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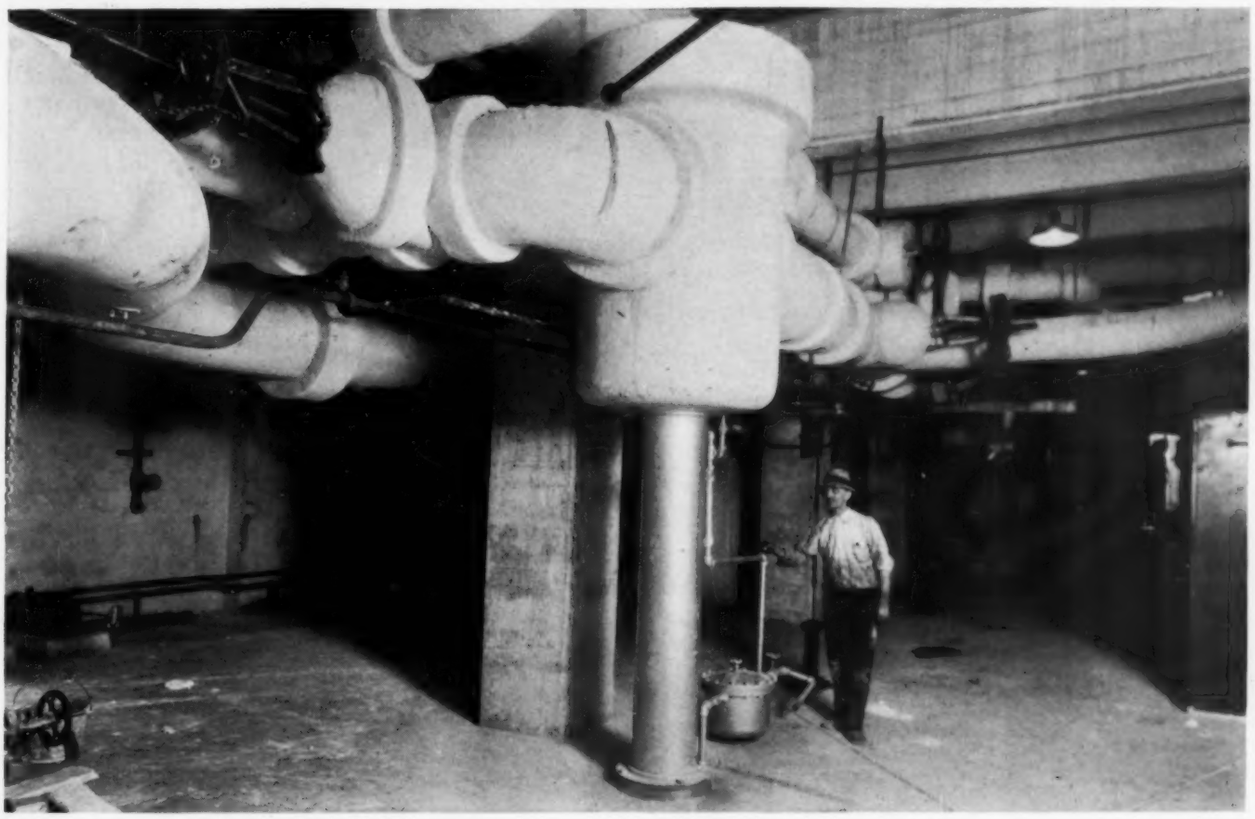
Heating · Piping and Air Conditioning



Typical installation of an absorption-type desuperheater. It has capacity to handle 85,000 lb of steam per hr at 35 lb, reducing the temperature from 367 to 281 F

Process Steam Plants Need Carefully-Designed Piping

INDUSTRIAL steam plants often present unusual problems in design due to the peculiar requirements and characteristics of the load which they serve. When process steam, as well as electrical energy, is a prime requirement of the plant, its design and the selection of equipment becomes quite complex. The piping for such an industrial steam plant is very important, and great care must be exercised in its design and detail, as it is usually quite complicated.

By **E. C. Gaston***

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Steam Requirements Vary Widely

A typical load to be served by a process steam plant is found in the modern paper mill and the piping practices to observe apply to many other industries. A mill with capacity to produce 180 to 200 tons of paper per day may require steam and electrical energy in the following quantities:

Steam (Maximum):

95,000 lb per hr @ 150 lb per sq in. pressure (gage).
85,000 lb per hr @ 35 lb per sq in. pressure (gage).

Steam (Average):
75,000 lb per hr @ 150 lb per sq in. pressure (gage).
70,000 lb per hr @ 35 lb per sq in. pressure (gage).

Electrical Energy:
9,600 kw, maximum.
8,000 kw, average.

The service requirements are exacting. The steam demanded by the mill may vary from zero to the maximum quantities shown above for either or both of the pressures at the same time, yet the delivery pressures cannot vary more than 5 per cent plus or minus without serious interruption to operations. Steam requirements are very fluctuating at both pressures, and the steam required bears no relation to the power demand; maximum process steam may be required simultaneously with a minimum electrical load and vice versa.

That industrial process steam plants present unusual design problems is emphasized in this article. Some of the particular problems are analyzed and data of use to a designer in solving them successfully are presented. Pressure-reducing stations, desuperheaters, and pipe lines for the long distance transmission of process steam are component parts of a process steam plant, and have as great a bearing on the satisfactory operation of the plant as do the turbines, boilers, and other such equipment. . . . . Too much attention cannot be given to piping and accessories by the designer of process steam plants.

These Points Influence Piping Layout

To meet exacting demands for steam and electricity and guarantee a continuous supply of both for any and all conditions, the plant design must take the following into consideration:

For insuring a continuous supply of electrical energy when the energy required is in excess of that which can be produced from the process steam used, it is necessary to tie into an existing transmission system; or if such is not possible, to provide a bleeder type condensing unit with a condenser of sufficient capacity to handle the additional steam required for the maximum condition; or, if the expense of a condenser does not seem warranted, to provide relief valves on each of the extraction lines with capacity to exhaust to atmosphere sufficient steam to produce the additional power required.

For insuring a continuous supply of steam when the steam required for process is in excess of the quantity required to produce the electrical load, it is necessary to provide reducing valve stations between the main steam header and both extraction lines for process steam.

For insuring process steam at required temperatures when bypassing steam from the main header, desuperheaters must be installed in the bypass connections either preceding or following the reducing valve stations.

For protecting the turbine in cases of emergency, it is necessary to install check valves in each extraction steam line as well as relief valves. The relief valves must have capacity for relieving each extraction line under maximum steam flow conditions.

The special equipment such as desuperheaters, reducing valves, relief valves, etc., in addition to the regular equipment such as feedwater heaters, water purification tanks, pumps, etc., makes for elaborate piping details in such a plant.

Design of the Process-Steam Piping

From a piping standpoint, one of the most interesting features of the design are the process steam lines leading from the steam plant to the load which they serve. These lines may vary from less than 100 ft in length to thousands of feet, depending on the general plant layout. In designing such a pipe line, the first step is to determine the pipe size. Determination of the maximum expansion to be expected, provision for caring for this expansion, method of supporting, anchoring, and draining the line follow to complete the design of the pipe line.

As an example, suppose it is required to design the pipe line for delivering process steam from a plant to a paper mill in the quantities and at the pressures mentioned previously for a 180-ton paper mill, the distance from the steam plant to the mill being approximately 500 ft.

Steam conditions for the low-pressure process work are as follows:

Maximum flow..85,000 lb per hr
Average flow ...70,000 lb per hr
Steam pressure .....
.....35 lb per sq in. (gage)
Temperature .....281 F

Babcock's formula for the flow of steam in pipes is:

$$P = K \frac{M^2 L}{D d^5} \left(1 + \frac{3.6}{d}\right)$$

P = pressure drop, lb per sq in.
K = constant = 0.0001321
M = steam flow, lb per min
D = density of steam, lb per cu ft
d = inside pipe diameter, in.
L = length of pipe line, ft

For a maximum flow of 85,000 lb per hr and a 12-in. diameter line:

$$M = \frac{85{,}000}{60} = 1{,}420 \text{ lb per min}$$

$$D = \frac{1}{8.514} = 0.1175 \text{ lb per cu ft}$$

$d = 12$ in.
$L = 500$ ft + 150 ft for entrance, valve and fitting loss.

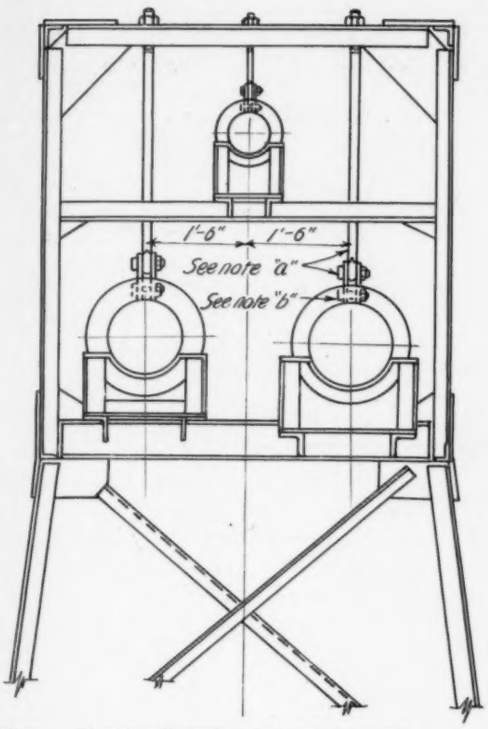
$$P = 0.0001321 \times \frac{(1420)^2 \times 650}{0.1175 \times (12)^5} \times \left(1 + \frac{3.6}{12}\right)$$

$P = 0.0001321 \times 44{,}830 \times 1.3$
$P = 7.70$ lb per sq in.

For an average steam flow of 70,000 lb per hr and a 12-in. diameter line:

$$M = \frac{70{,}000}{60} = 1{,}170 \text{ lb per min}$$

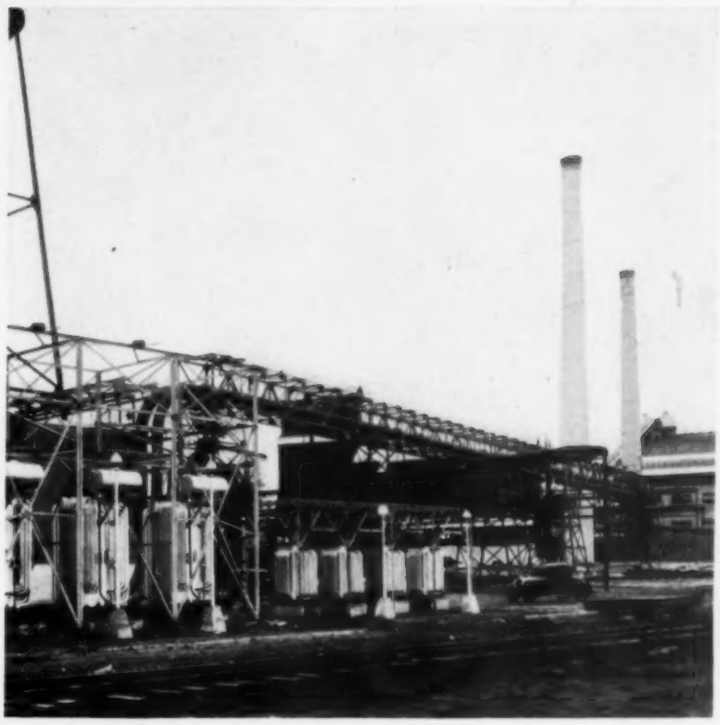
$D = 0.1175$ lb per cu ft
$d = 12$ in.
$L = 650$ ft



Above (Left)—Detail of hangers and anchors for a process steam line. Use of box-type girders supported on towers widely separated may require slightly more steel than simple A-frames closely spaced, but where foundation costs for tower footings are a considerable part of the total cost, the box-girder type may prove the more satisfactory

[a] **Eye bolt must be entirely outside covering.**

[b] **Bolt clamping band to pipe is to be below covering.**



Above (Right)—Process steam lines serving a paper mill, a 14-in. line for 35-lb steam and a 12-in. line for 150-lb steam. Overhead construction was chosen because of sandy soil conditions in the particular locality, to keep the line in full view of the operator, and to facilitate the use of expansion bends and draining the piping

$$P = 0.0001321 \times \frac{(1170)^2 \times 650}{0.1175 \times (12)^5} \times (1 + \frac{3.6}{12})$$

$$P = 0.0001321 \times 30{,}500 \times 1.3$$

$P = 5.25$ lb per sq in.

In like manner calculations were made for 14-in. O. D. and 16-in. O. D. lines. The following table shows the result of such calculations:

For the maximum flow of 85,000 lb per hr:

Pipe Size	12" *I. D.*	14" *O. D.*	16" *O. D.*
Velocity, fpm	15,300	12,500	9,500
Pressure drop, lb per sq in.	7.70	4.60	2.20

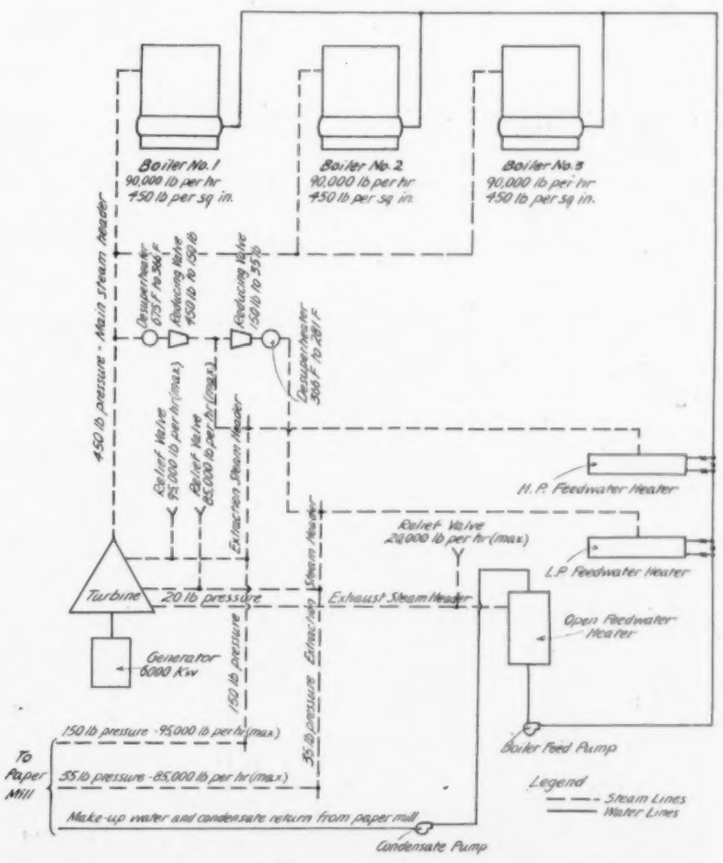
For the average flow of 70,000 lb per hr:

Pipe Size	12" *I. D.*	14" *O. D.*	16" *O. D.*
Velocity, fpm	12,600	10,400	7,800
Pressure drop, lb per sq in.	5.25	3.15	1.55

Heat Available for Power Depends on Drop in Piping

For each pound pressure drop in the pipe line, the extraction pressure at the turbine must be raised correspondingly, resulting in a decreased amount of heat available for conversion into electrical energy. From the above calculations, assuming a 12-in. pipe line to be installed, there is a 7.70 lb per sq in. pres-

Below—Steam and water piping for a process steam plant serving a paper mill, a typical load requiring process steam at two or more pressures. Location of the desuperheaters and reducing valves, with relation to each other, is shown



sure drop when passing a total of 85,000 lb of steam per hr at 35 lb per sq in. gage. This means that the pressure at the turbine extraction opening, instead of being 35 lb per sq in., will be 42.7 lb. This increase in extraction pressure results in a decrease of 10 Btu per lb of steam available for power production.

In like manner, the loss in heat available for power production (in Btu per lb of steam) can be determined for the various pipe sizes and steam flows, the results being as follows:

Steam Flow	*12" I. D. Pipe*	*14" O. D. Pipe*	*16" O. D. Pipe*
85,000 lb per hr (max.)	10.0	5.0	3.0
70,000 lb per hr (ave.)	7.0	3.5	2.0

Choosing the Economical Pipe Size

In order to determine the most economical pipe line, it is now necessary to estimate the annual kw-hr loss for each size line as compared to the next larger size. The kw-hr loss becomes greater as the line becomes smaller due to increase in pressure drop in the line. Since a larger pipe line permits a larger kw-hr generation from the plant, the value of this incremental increase in power must offset fixed charges on the added cost of the pipe line.

Assuming an annual operating condition requiring 5,000 hours operation at average load (70,000 lb steam per hr) and 1,000 hours operation at maximum load (85,000 lb steam per hr), the increase in power generation by using a 14-in. line instead of a 12-in. is:

$$\frac{HQhE}{3416} = \text{annual increment generation}$$

H = increase, per lb steam, in Btu available for power generation
Q = lb steam per hr
h = annual hours operation
E = generator efficiency

Kilowatt hours × 3416 = Btu

$$\frac{(7-3.5)\times 70{,}000\times 5{,}000\times 0.90}{3416} = 323{,}000 \text{ kw-hr}$$

$$\frac{(10-5)\times 85{,}000\times 1{,}000\times 0.90}{3416} = 112{,}000 \text{ kw-hr}$$

Thus it is found that the total increase in power generation resulting from using a 14-in. line instead of a 12-in. line is 435,000 kw-hr annually. In like manner, it develops that only 185,000 kw-hr additional generation can be secured by using a 16-in. instead of a 14-in. line.

The cost of each size line (500 ft long) including valves, fittings, hangers, guides, steel supporting structure, foundations, insulation, and drains, completely installed is estimated approximately as follows:

Pipe Diameter	*Total Cost*
12" I. D.	$ 7,500
14" O. D.	10,500
16" O. D.	12,500

If the additional cost of the larger pipe lines must be paid off in four years, then the cost of the incremental power produced in the case of 14-in. and 16-in. lines is:

For the 14-in. line:

$$\frac{(10{,}500-7{,}500)\times 0.25}{435{,}000} = 1.72 \text{ mills per kw-hr}$$

For the 16-in. line:

$$\frac{(12{,}500-10{,}500)\times 0.25}{185{,}000} = 2.70 \text{ mills per kw-hr}$$

A plant located where power can be obtained at 2.0 mills incremental cost, can then select a 14-in. pipe line for the distribution of the low-pressure steam. An isolated plant, furnishing the entire steam and electrical requirements, would probably select a 16-in. line, or perhaps an even larger one, depending on the actual hours operation and load characteristics.

Providing for Piping Expansion

Having selected the most economical pipe size, the next step is to determine the maximum expansion, and make provisions for it in the layout of the line. For a 14-in. line, with a maximum steam temperature of 281 F and an outside temperature of 60 F, the expansion in 500 ft of pipe may be calculated as follows:

$E = 1200\ C\ (T-t)$
E = expansion, in. per 100 ft pipe
C = coefficient, 0.0000067 for steel
$(T-t)$ = temperature difference, F

Substituting in the above equation:

$E = 1200 \times 0.0000067 \times (281-60)$
$E = 1.78$ in. per 100 ft pipe or 8.90 for 500 ft

In the case the author has in mind double offset U-bends were used, the following formula being the basis of their selection:

$$E = \frac{0.013\ R^2}{d}$$

E = expansion provided for, in.
R = mean radius of bend, in.
d = outside diameter of pipe, in.

For 14-in. O. D. pipe with bends having a mean radius of 72 in., the expansion allowed for per bend is:

$$E = \frac{0.013\times 72\times 72}{14} = 4.82 \text{ in.}$$

Two double offset U-bends are adequate to care for the total expansion in 500 ft of 14-in. O. D. pipe delivering a maximum of 85,000 lb steam per hr at 35 lb per sq in. gage and 281 F temperature.

The above calculations cover only the piping for the low-pressure (35-lb) steam. In like manner, the most economical pipe size, the maximum expansion, and the number of expansion loops required for the 150-lb process steam can be determined.

It is very important that the designer note the exact location of all guides, anchors, and spring supports on all layout drawings. It is not sufficient to calculate expansion carefully, accurately determine the type and number of expansion bends required, and then ignore or carelessly locate guides and anchors. The function of guides and anchors is most important; when properly located, they force the pipe to move in the directions desired. Broken flanges and fittings, bursted pipe, and leaking joints are frequent results of the complete omission or incorrect location of guides and anchors.

The proper draining of long pipe lines transmitting low-pressure steam is an important item. It must be provided for in the design and layout of the line in order to secure best results. Automatic operating steam

traps are to be located at points where abrupt changes in steam flow occur, particularly at points where the change in flow is in a vertical direction. In order to insure positive draining of the lines, drain piping should be sloped toward the trap and in the direction of steam flow, the minimum pitch of the slope to be not less than 3 in. per 100 ft of pipe.

The drainers may exhaust to heat exchangers, to feedwater heating equipment in the plant, or direct to atmosphere. If remotely located with reference to the plant, the expense of recovering the drain is usually unwarranted.

Reducing Steam to Two or More Pressures

Where it is required to supply steam from a high-pressure source to two or more lower pressures, this can be accomplished:

By installing the pressure-reducing stations in series.
By installing the pressure-reducing stations in parallel.

The operating pressure selected for the process steam plant to serve the paper mill specified above was 450 lb per sq in. To guarantee a continuous supply of process steam to the mill regardless of the electrical demand, two reducing-valve stations are required. One of these must have capacity to deliver a maximum of 95,000 lb per hr at 150 lb per sq in. and the other must deliver a maximum of 75,000 lb per hr at 35 lb per sq in.

An arrangement of reducing valves in series has several advantages in meeting such requirements. By using the valves in series only one is required to handle 450-lb steam; this reduces the cost of the second valve since it can be 250-lb standard rather than 600-lb standard. Then, too, if the reducing valves were placed parallel, both operating from 450-lb steam, the pressure drop from 450 lb to 35 lb would probably be made through two or more valves in series. Thus, two or more valves in series would be required in the one pressure-reducing station, increasing the initial cost of the equipment, as well as adding more moving parts, thereby increasing maintenance.

If the 35-lb steam represents a steady steam flow, by placing the two pressure-reducing stations in series, the operation of the 450 lb-150 lb reducing valve may be improved as this valve must pass all of the 150 and 35-lb steam and will not be required to operate from extreme open and closed positions in order to deliver the maximum and minimum quantities of 150-lb steam.

The large pressure reduction and the frequent variation in process steam from zero to maximum quantities with an allowable variation in delivery pressure of only 5 per cent plus or minus make for exacting service requirements. To meet such conditions, the selection of the valve and the design of the reducing station should follow along these lines:

Select a valve of such design that, when operating at the minimum or nearly closed position, the wear on the seat and disc is minimized. This is very important, if minimum steam flows are to be required for frequent or extended periods of time. A valve not suited for operation under such conditions will require excessive maintenance, and will cause much operating grief due to the increased attendance required and the difficulty in maintaining delivery pressure within the prescribed limits.

Select a rugged, durable valve, with adequate throat area for maximum steam flow, designed for positive maintenance of constant delivery pressure throughout the entire range from maximum to minimum conditions.

In order to insure accurate response of the reducing valve to changes in steam flow, and to assure minimum time lag between a change in steam flow and a change in the setting of the valve, the connection between the pilot valve and the discharge line from the reducing valve should be tapped into the discharge line as near to the point of delivery to the customer as is possible. The pilot valve must be rugged, positive in operation, and instantaneous in response to steam flow variations.

To insure a continuous supply of steam even when the reducing valve is out of service for repairs or other reasons, a suitable bypass must be provided around the valve. This bypass should have capacity for passing the maximum quantity of steam required, and be provided with a standard globe valve for hand operation to regulate pressure.

Installation of Desuperheating Equipment

Where steam is reduced from one pressure to another and the temperature at the reduced pressure must be maintained lower than the initial temperature of the steam, the installation of desuperheaters becomes necessary.

Desuperheaters may be divided into two general classifications, the spray type and the absorption type. In the spray type, the water comes in direct contact with steam by means of water jets located inside of the desuperheater, and its usual applications are for installations where the steam flow is fairly constant, and where water for desuperheating is available at sufficiently high pressure (at least 30 lb above the steam pressure).

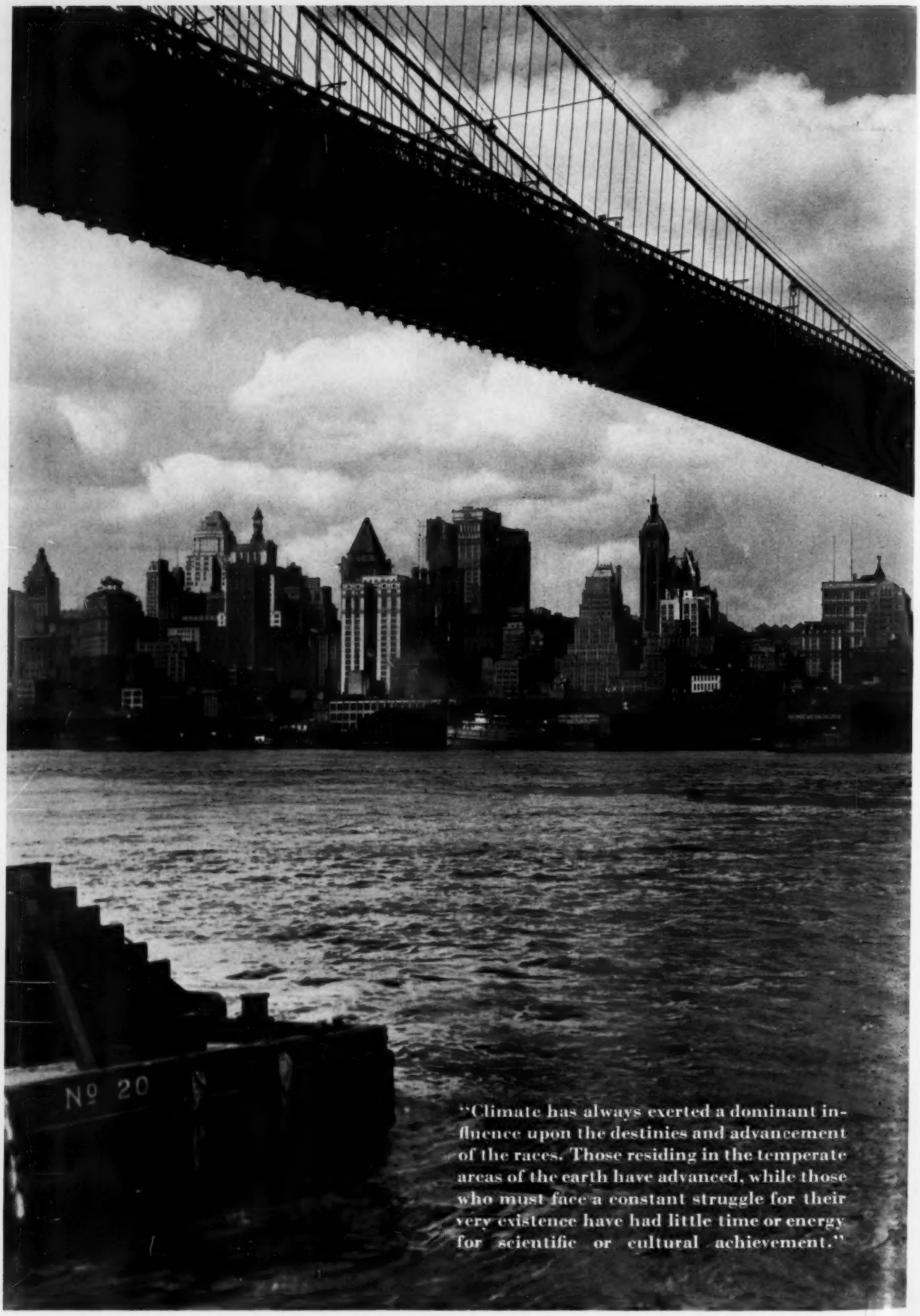
In the absorption type desuperheater, the water is allowed to trickle down through metal rings or mesh and is absorbed by the steam passing through, the desuperheating being affected both by the evaporation of the water and by the cooling effect of the metal over which the water is sprayed. This type of desuperheater is suitable for installations in which the steam flow varies over a wide range, and in which there should be a corresponding variation in water flow. It is adaptable to installations where the water pressure available is only a few pounds above the steam pressure.

Select the type desuperheater best suited to the load conditions, and make certain the equipment is adequate for maximum steam requirements.

Provide a suitable water supply, with a pressure regulator to maintain a constant pressure differential between the water supply and the steam, and with a thermostatically-controlled regulator for regulating the water supply to the desuperheater. The thermostat and regulating equipment are most important parts of the desuperheating equipment, and deserve major consideration in the selection and layout of the equipment.

Provide an adequate drain from the desuperheater. This consists essentially of a small trap, with bypass arrangement, for removing the excess water. The evaporation of the water will not be 100 per cent, regardless of the thermostat and water-regulating equipment installed. This is particularly true with minimum steam flow conditions. The desuperheater will not operate satisfactorily unless adequate provision is made for removing excess water from its shell.

Locate regulating equipment and draining equipment conveniently for the operator as this is the part of the equipment requiring most attention.



"Climate has always exerted a dominant influence upon the destinies and advancement of the races. Those residing in the temperate areas of the earth have advanced, while those who must face a constant struggle for their very existence have had little time or energy for scientific or cultural achievement."

Air Conditioning Is Saving Industry $15,000,000 Yearly

This saving could be quadrupled, estimates Willis H. Carrier* . . . Pictures even greater opportunities in air conditioning for human comfort and health

CLIMATE has always exerted a dominant influence upon the destinies and advancement of the races. Those residing in the temperate areas of the earth have advanced, while those whom time and circumstance have placed in tropic jungles or in Arctic wastes, where they must face a constant struggle for their very existence, have had little time or energy for scientific or cultural progress.

Ages ago we learned to heat the air and thus make it possible to inhabit, throughout cold seasons, sections of the earth which otherwise would have been forbidding. But temperature is only one phase in our new command of the conditions of the air which surrounds us. We have also learned to clean the air; to free it from dust and objectionable foreign matter. We have learned to establish and control any desired condition of humidity, which is just as important to our comfort and health as temperature. In summer we can—by dehumidification—relieve the muggy oppression of humid days; in winter we can add moisture to the air, alleviating that parching, arid condition common to the artificially heated, but un-humidified, building.

In fact, it is possible now to simulate any climate and to maintain these conditions within an enclosure regardless of the season, the weather, or the geographical location. For instance, a laboratory cabinet has been devised which enables observation of the growth of plants and their parasites under the temperature, humidity, light and air pressure conditions existing at the bottom of Death Valley or on top of Pike's Peak.

In a South American mine, 7,000 feet below the surface of the earth, temperatures exceed 120 F and the air is almost saturated with moisture. Air-conditioning equipment, placed immediately in the workings, has corrected this condition, brought humane comfort to workers, and allowed the work to proceed efficiently to the profit of the owners.

Air conditioning found its inception in the demands of industry in order that the manufacturing of certain weather-sensitive products might be independent of weather, seasons, or geographical locations.

While the textile industry at one time could be successful only in regions having a naturally moist climate, great mills are operating today in the cotton fields near the source of supply because air conditions best suited to each manufacturing process are maintained within the mills by modern air-conditioning equipment.

Air conditioning is applied to a great variety of industrial processes and, therefore, there is necessary a wide diversity in the character and method of its application. In some installations the primary purpose is to produce a humid climate with only a reasonable degree of temperature reduction, which though of practical advantage is incidental; in many other cases a rigid control of temperature with a lowering of the relative humidity is required.

The first type aims at increasing humidity and is used in textile mills, tobacco factories, etc. The second type of air conditioning has a larger field as it applies to all processes that are affected by temperature as well as humidity, such as the manufacture of confectionery, in modern bakeries, in the manufacture of cigars and cigarettes, and in lithographing. It is used in the automatic packaging and wrapping of goods and in the drying of certain products at low temperatures, such as photographic films, chewing gum, and summer sau-

"Air conditioning should not be viewed merely as an expensive luxury. The benefits from air conditioning in industrial installations bring large returns on the investment by increasing the efficiency of production.

"Air conditioning applied to human comfort not only contributes to human welfare but creates a new and rapidly increasing demand, usefully aiding and taking up the slack of unemployment in technological advance in this and other fields. It may be the key to the successful exploitation of the wealth of the tropics. As an industry, it is yet in its infancy, and of its possibilities the surface only has been scratched. Upon the development of industries such as this our industrial and social progress and well-being depends."—The Author.

* Chairman of the Board, Carrier Corporation. From an address before *American Institute of Electrical Engineers* meeting in New York City, Oct. 26, 1932.

sage. It is used most successfully in many processes of the manufacture of ceramics from terra cotta tiles to dishes. The Simonds Saw and Tool Co., Fitchburg, Mass., has applied it as a necessary adjunct to their windowless factory where saws are to be manufactured under artificial light and artificial ventilation, maintaining ideal conditions regardless of external conditions. More than two hundred industries have up to now found air conditioning an indispensable servant, freeing the progressive manufacturer from daily weather uncertainties, improving the quality of his product, and contributing to the health and efficiency of his workers.

Air Conditioning Ups Production, Downs Cost

In general, industrial applications of air conditioning are warranted whenever the tangible or direct savings will pay for the cost of the installation within three years. The economic requirement is that the cost of owning and operating, which includes interest, liberal depreciation and maintenance, shall be considerably less than the economies effected by the installation. Frequently economies effected by air-conditioning installations are almost startling. One ceramic manufacturer found it was possible to double his production without increasing his factory floor space as he had intended. The cost of a relatively small air-conditioning system was only one-fifth of the cost of the proposed increase in building. In addition, the quality of his product was improved and the reduction in losses in production more than paid for the equipment every year. To give another instance, a large tobacco manufacturer saved in one department by the reduction of the amount of scrap tobacco enough to pay for the initial cost of the equipment six-fold in one year.

"More than two hundred industries (a few are shown opposite) have up to now found air conditioning an indispensable servant, freeing the manufacturer from daily weather uncertainties, improving the quality of his product, and contributing to the health and efficiency of his workers"

Saving Made in One Plant Typical

An interesting study has been made by the Philadelphia Electric Company in one of the factories of the American Cigar Company. The object of the study was to determine the benefits derived from the addition of refrigeration equipment to the existing air-conditioning system by which the plant was enabled to maintain desired conditions of humidity and temperature in summer as well as in winter. It was found that the investment in this addition to the installation amounted to $34,000. The gross savings for a single season in but one of several departments which were served amounted to $29,546, which was broken down into items as follows:

Increase in production	$16,392
Reduction in rejected products	3,204
Reduction in lost time	4,950
Reduction in labor turn-over	5,000
Total	$29,546

Total fixed charges and operating costs amounted to $6,174.50 for the year, leaving a net annual saving in this one department of $23,371.50.

Estimated Present and Future Saving to Industry

In general, industrial air-conditioning installations where now in use may be conservatively expected to pay for themselves every two years. As industrial air-conditioning installations are increasing, the savings to industry are increasing in proportion. If we may estimate the present value of industrial applications of air conditioning in this country at $30,000,000, then under normal conditions they are probably producing economies of at least $15,000,000 annually.

The rate of industrial applications is an accelerated one, as in the author's opinion, not more than one-fourth of the manufacturers and industries which could be benefitted by air conditioning have as yet availed themselves of these possible economies. If this is true, it is possible for the balance sheet for industrial applications of air conditioning to show annual savings aggregating $60,000,000 instead of $15,000,000.

Economic Aspect of Industrial Air Conditioning

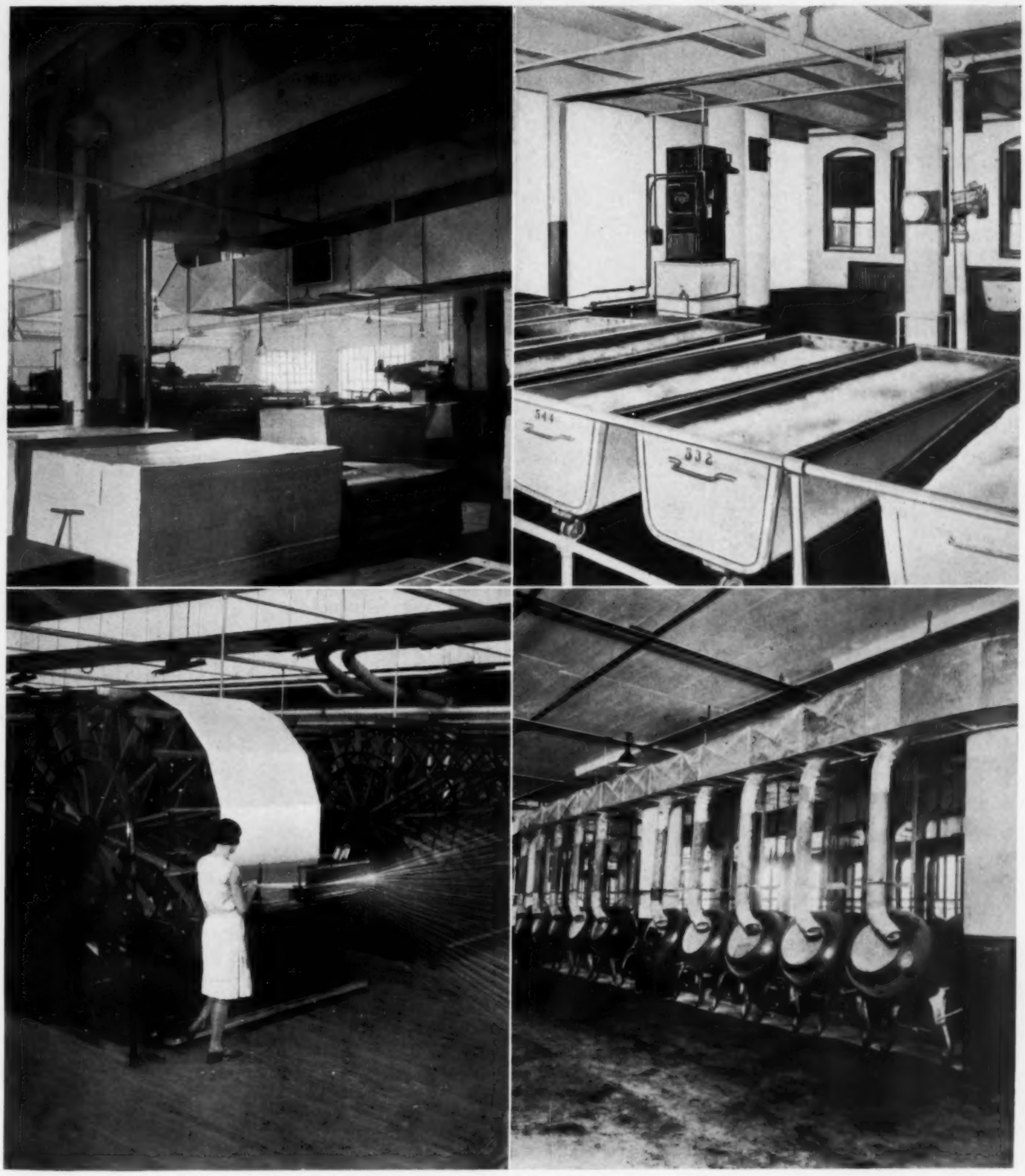
Air conditioning from the standpoint of economics is considered in this paper. But, the economist will say "wherever you are making savings in cost of production by the use of air conditioning you are necessarily decreasing the over-all labor requirement not only in the industries themselves but considering industry as a whole including the manufacture of air-conditioning equipment and the appurtenances thereto." It is axiomatic that if the over-all labor requirements were not reduced then there would be no purpose in applying air conditioning to industry or, in fact, in applying any other improvement.

It must be admitted that air conditioning as applied to certain branches of industry does reduce the labor requirement of industry as a whole except for one feature. Lower cost of production results in lower prices and increases the demand for a product, as in the case of rayon where air conditioning and refrigeration are indispensable for low-cost production. Thus, increased consumption may to some extent offset the labor reduction resulting from the lowered unit cost.

The Future of Air Conditioning for Comfort

Fortunately, however, there is another field of air conditioning which creates a new demand, a new market, and has the possibility of much more than making up for the economies in labor resulting from the application of air conditioning to industry. *I refer to air conditioning for human comfort.* This is a new and most fascinating field, and it is this field which, to my mind, has the greatest potentialities for making air conditioning a great industry.

Although the basic principles and practice of air conditioning have been well known for more than twenty



years, it is only within the last eight that its vast importance in increasing human comfort and efficiency has begun to receive public acceptance.

As a pioneer in this particular field, as well as in the general field of air conditioning, I am naturally enthusiastic concerning its future prospects. Any economic predictions that I may make might well be prejudiced, but I find that I have plenty of excellent company. Others who view the possibilities of the industry from the outside often outdo me in their enthusiasm concerning future possibilities in this field.

Why Humans Need Conditioned Air

Let us turn for a few moments from generalities to the concrete facts of man's physiological requirements. The human being is a heat engine—a prime mover. The fuel of this heat engine is his food. The energy produced within his body is brought about by the oxidation of this fuel by the air with the result that only a portion of this energy (according to the same law of thermodynamics that governs the steam engine, for example) is convertible into mechanical energy or useful work,

while the greater portion must be removed from the body in the form of sensible heat, just as it is removed in power plants by the condenser of the turbine. The maximum thermal efficiency obtainable in the human being as a heat engine has been actually measured and is found to be approximately 17 per cent, a very worthy performance comparable with that of the most efficient power plant.

As we all know, the human body has a very ingenious method of controlling the disposal of this large quantity of waste heat. Normally, the greater portion of heat from the body is dissipated as sensible heat by radiation to surrounding objects and conduction to the surrounding atmosphere, yet we have all of us probably lived in air temperatures that were above the body temperature. People do not necessarily die in the American desert with temperatures frequently reaching 120 F. The reason is that the body can, under extreme conditions, dispose of all of its heat by evaporative cooling through perspiration, just as a cooling tower functions in a power plant. In fact, the skin *is* the cooling tower of the human power plant. It is for this reason that an increase in moisture content of the air is more serious than an increase in the temperature.

The controlling factor in the maximum possible rate of cooling through perspiration is the wet-bulb temperature of the surrounding air. If the wet-bulb temperature goes above 85 F, as in certain mines, effective work becomes almost impossible, while above 90-F wet bulb the body temperature would rise rapidly, resulting in death.

Fortunately in no climates on this earth do the maximum wet-bulb temperatures greatly exceed 80 F. If this were not true, the earth would not be inhabited by human beings. Although the heat-control mechanism of the body is wonderfully flexible and sensitive, and even though man can exist under extremes of cold or of heat and moisture, he cannot endure such conditions without considerable discomfort and loss of efficiency.

Research Has Determined Proper Air Conditions

A most thorough and interesting line of research has been carried on for the last ten years by the *American Society of Heating and Ventilating Engineers* at their Research Laboratory, Bureau of Mines, at Pittsburgh. Here many facts regarding the relative effect of temperature, humidity, and air motion have been discovered and co-ordinated, so that today we are able to tell what the optimum desirable conditions for an average group of persons are. We are also able to tell how the heat is dissipated and the proportion of sensible to latent heat under various conditions; also how the efficiency of the human body is affected by variations in atmospheric conditions. These investigations established a scale of reference which has been termed "Effective Temperature."

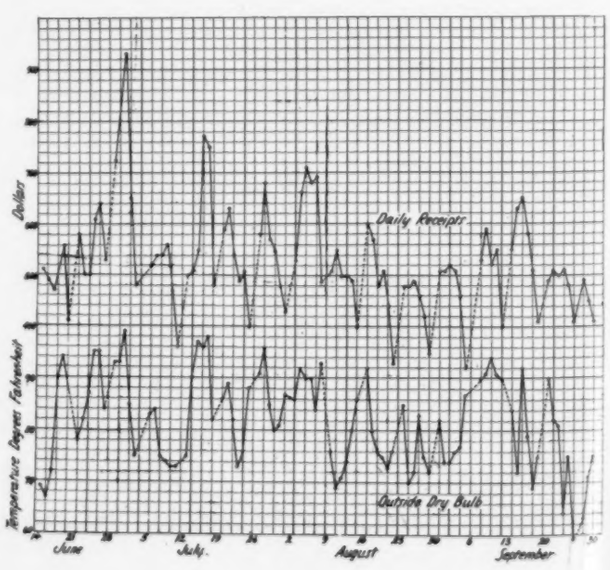
It is well known that the sensation of warmth depends upon humidity and air motion fully as much as it does on temperature. By taking the temperature of still, saturated air as a basis of comparison, we are able to set up a definite scale for human comfort under widely differing atmospheric conditions.

It may surprise many to know that the average adult at rest gives off as much heat as a 120-watt incandescent lamp—about 400 Btu per hr; enough heat, could it be converted completely into mechanical energy, to raise the body 32 fpm. For a person performing work it would be two to three times this quantity.

The proportion of heat that is given off from the human body as sensible heat, and that which is given off as latent heat through evaporation from the skin and lungs, has also been determined accurately at the *A. S. H. V. E.* laboratory. The amount of sensible heat given off depends upon the air temperature, while the surplus heat which can not thus be removed is disposed of by evaporation. This is the function that the delicate mechanism of the body controls so perfectly as to give a heat balance under widely varying atmospheric conditions without any appreciable change in body temperature. There is, however, a noticeable change in skin temperature, or skin sensation of warmth, which makes us comfortable or uncomfortable under conditions other than those that are ideal.

Prof. C. P. Yaglou, at Harvard University, has measured the various degrees of comfort or warmth corresponding to different effective temperatures. Not all people are equally comfortable under the same conditions. On a large number of subjects tested he finds, for example, that in the winter time an effective temperature corresponding to 71 F and 40 per cent relative humidity gives the greatest feeling of comfort, while in mid-summer conditions with the customary clothing the greatest feeling of comfort corresponds to 76 F and 50 per cent relative humidity, or an increase from 66 F in winter to 71-F effective temperature in summer. This is a fact that we did not know until recently, nor until the effective temperature scale was devised did we have any means of correlating conditions of temperature, humidity and air motion.

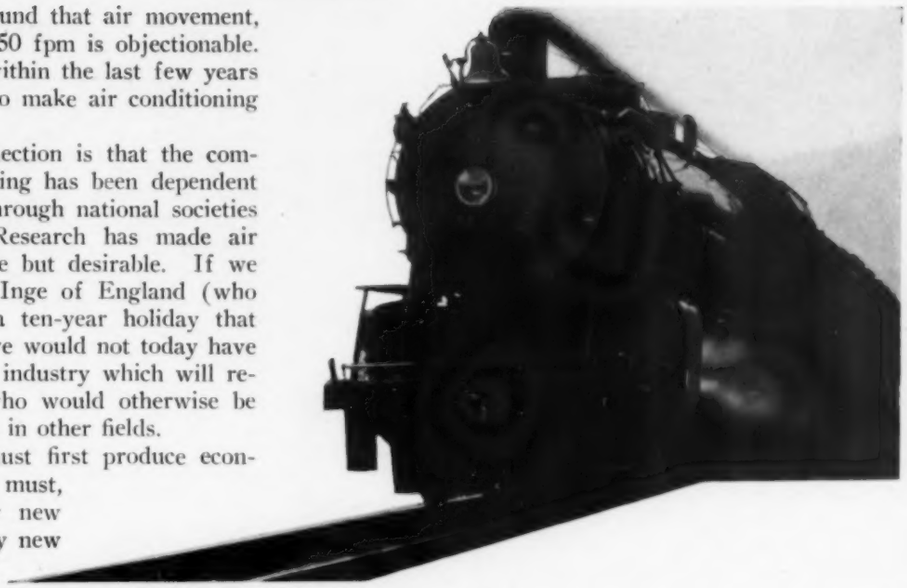
Some air motion is always desirable for the highest degree of comfort; but excessive air motion is not only uncomfortable but dangerous. One of the greatest developments in the application of air conditioning has been in the systems and methods devised for air distribution to produce the necessary air change without



causing drafts. It has been found that air movement, or air turbulence, in excess of 50 fpm is objectionable. Great strides have been made within the last few years in methods of air distribution to make air conditioning practicable.

The point made in this connection is that the commercial success of air conditioning has been dependent upon scientific research work through national societies and industrial corporations. Research has made air conditioning not only practicable but desirable. If we had taken the advice of Dean Inge of England (who suggested that scientists take a ten-year holiday that civilization might "catch up") we would not today have the possibility of a wholly new industry which will require the labor of thousands who would otherwise be unemployed because of advances in other fields.

Research and development must first produce economies in labor, but then they must, and do, go further to supply new products and to develop not only new demands but demands that a few years ago were never dreamed of, of which air conditioning is a pertinent illustration.



"We will scarcely think of taking an extended railroad trip unless we ride in conditioned cars free from dust and noise." . . . Where the effect of air conditioning is shown directly on the balance sheet, its applications are many. Hotels find air conditioning a valuable way of attracting guests. The chart shows how receipts of a conditioned restaurant vary with the outdoor temperature. On hot days, volume of business often doubles

Theater System Pays for Self First Summer

Any device which will increase man's comfort and his satisfaction with his surroundings tends to increase his efficiency. Further, if such a product actually improves the conditions affecting his health, and decreases the fatigue from his day's labor, then its economic advantage is unquestionable providing it can be produced at a cost commensurate with the returns. In other words, it must pay its way either through increased productivity or through increased comfort and health. What are the returns in air conditioning? The first installation of air conditioning in a theater in New York City in 1924 paid for the entire installation the first summer that it was operated. It increases the summer attendance fully 50 per cent and the average yearly attendance from 12 per cent to 15 per cent while the cost of air conditioning varies from 5 per cent to 10 per cent.

Air Conditioning Pays Its Way in Stores

In the department store, air conditioning pays its way. The lower floor and basements where nearly one-half the sales are made are usually conditioned. The cost of owning and operating an air-conditioning system is less than one-half of 1 per cent of the total sales for the year. Since it is the summer sales that are chiefly increased, it requires less than a 2 per cent increase for a three-month period. Judging from the results of air conditioning at Macy's, as an illustration, the increase in purchasers and presumably the increase in sales during this period is several times this amount.

Office Buildings Save with Air Conditioning

I am confident in predicting that within a few years the office building that is not air conditioned in summer as well as in winter will be wholly obsolete. Today, air conditioning is being applied to entire office buildings at an owning and operating cost of from 18c to 25c per sq ft of rentable area. Not all of this increase in cost,

however, is chargeable to the air-conditioning equipment, as a certain expense for ventilation and additional heating would be required in any event. It is probably fair to say that the increased cost of owning and operating due to air conditioning would be from 14c to 20c a sq ft annually. In these days of competitive building an average of 80 per cent occupancy may be considered quite normal. If the addition of air conditioning will increase the occupancy 5 per cent to 10 per cent, it will pay for itself without any increase in the rental rates. On the other hand, when the building is satisfactorily rented the cost of owning and operating would be met by an increase of rental of from 14c to 20c a sq ft a year.

There are also other advantages to the building owner. The cost of cleaning and renovating are reduced practically to one-half as windows can be kept closed, dust excluded, and only clean air used. Further than this, locations that otherwise would be undesirable become readily rentable and the practical rentability of the floor space is thus increased. A tenant would pay 10 per cent, or even 25 per cent, more rental, if he could spend his working hours, and receive his clients, in a climate that was ideal the year around. His increase in personal efficiency would generally pay many times over the cost of this extra rental.

It certainly must pay to provide air conditioning for human beings when it even pays to air condition for cows, as is done at the Walker Gordon Plant at Plainsboro, N. J. The only difference between the human being and the cow is that for the cow you have a definite measure of efficiency which will show on the balance sheet, while no such exact record can be kept for the performance of the human individual. This reminds me of the story about the farmer to whom an agent was trying to sell an incubator, using the argument that it would save the hens' time. Said the farmer, "What in hell do I care about hens' time?" yet millions of dollars worth of incubators are sold today to save the hens' time. Just so in the future, air conditioning will be sold not only to improve the personal efficiency of the higher executives but of an entire office force. In one office building in Chicago which was remodeled and had air conditioning installed (a more expensive operation than installing at the time of the construction of the building) the cost is actually 4/10ths of 1 per cent of the payroll. When it can be shown that the annual efficiency of a cow is increased 7 per cent by air conditioning and cooling during the summer months, may we not expect fully the same increase in the efficiency of human beings?

The Metropolitan Life Insurance Company, after making a thorough study of the possibilities, have air conditioned their new 33-story office building for their employes in New York from top to bottom. Thirteen hundred tons of refrigeration, with a demand load of over 1500 kw for the entire conditioning plant, are required.

Indeed, it seems quite possible that air conditioning for human comfort will realize calculable as well as intangible returns that are fully as great as those realized in manufacturing. Whether we will ever come to windowless offices, artificially lighted and completely air conditioned, I do not know, but such construction on the first fifteen floors of metropolitan buildings would certainly be made practicable by air conditioning, and very probably desirable. One of the great advantages to the occupant is that in addition to securing perfect comfort, regardless of weather conditions, he is always provided with adequate ventilation which enables him to keep his windows closed, thus shutting out the dust and din of the city streets below. Anyone spending his working days in metropolitan offices can appreciate what this means in economy as well as comfort. The fatigue at the end of the day, for one thing, is markedly decreased. This is from my own personal experience as well as corroborated by the experience of others.

Railroads Increase Traffic with Air Conditioning

The railroads and the Pullman Company are now looking forward to completely-conditioned trains in practically all parts of the United States. Within a very few years we will scarcely think of taking any extended railroad trip in summer, either by day or night, unless we ride in perfectly cooled and air-conditioned cars free from dust and noise. Railroads look upon it as a means of increasing the sum total of traffic by reducing the amount of diversion to other modes of travel. In this they are undoubtedly correct. As in the case of the theaters, when one road starts the others must follow. I have the personal satisfaction of designing the first mechanically air-conditioned car ever operated on a railroad—the diner "Martha Washington" on the B. & O.—and the B. & O. may claim the honor of being the first railroad to demonstrate the practicability of air conditioning in passenger service, although they are run a close second by the Santa Fe and the M. K. & T.

"An air-conditioning system in a theater paid for the entire installation the first year it was operated. It increases the summer attendance fully 50 per cent and the average yearly attendance from 12 to 15 per cent"

Air Conditioning for Homes Will Be Common

You may ask yourself if the individual experiencing the comforts and benefits of air conditioning in his factory, his office, his restaurant, his theater, and the railroad on which he travels, will rest content until he has equal advantages and comfort in his home. Eventually this is bound to come. Even today complete air-conditioning installations can be made at relatively moderate cost in the larger homes, and equipment is available that, by merely turning a switch, will either heat and humidify or cool and dehumidify as required. The shift from warm to cold is immediate and spectacular. In relatively few years, if permitted by our expected economic

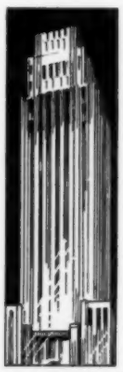
advancement, air conditioning in summer in the home will be almost as common as good heating in winter. Instead of merely having comfort in winter we will enjoy maximum comfort the year round.

Air Conditioning Aids Development of Tropics

The wealth of the tropics has been the lure of mankind since history has been recorded. If it is less so today than in the past it is simply because of the more perfect development of our own immediate resources. As a potential field, it is still as great as ever.

The great drawback which has always existed in the exploitation of tropical wealth is that the climate is not well suited to man, especially to the northern race of men, who by reason of their superior climate have been able to advance to present heights of intellectual, social, and material progress—excepting, of course, our present, and I hope fleeting, discomfort.

If we could convey our northern climate to the tropics, then we would have an ideal combination. I feel that I am correct in stating that, if in the tropics the northern man could spend at least 50 per cent of his time under ideal climatic environment, during the remainder of the time he would be able to resist almost any objectionable conditions of heat and humidity. This becomes very obvious when we find men working strenuously in the excessive heat of the rolling mills day after day, and in other similar industries, without loss of energy or vitality. It is because they are able to give their organisms a rest from this unnatural and trying condition. In the tropics, as conditions exist today, this is not so. They suffer the entire twenty-four hours, day after day, from the languorous effect of combined heat and moisture, without relief and without the tonic of atmospheric change. Two years of such life is the limit of endurance for some. Others annually, in India for example, spend a large part of the year in Simla in the mountains where the climate is temperate, and thus secure the needed relief. Artificial air conditioning in the office, in the club, and in the home, would afford the necessary relief and maintain the vigor of the individual at a point probably equal to that experienced in our temperate climate. He would obtain not merely comfort but health; not merely luxury but efficiency. It would solve the problem of successful and efficient living for the white man in these regions, and it would make possible the successful exploitation of the great natural resources of the tropics thus adding greatly to the material advancement of mankind generally.



Similarly, deep mines that cannot be operated practically or profitably owing to the heat and humidity can be restored to their original efficiency by air conditioning and refrigeration in their depths. This is being done today in one notable gold mine, the Morro Velho Mine of the St. John del Rey Co., Estat de Minas, Brazil. Through air conditioning, unprofitable operation may be converted into profitable operation.

What Air Conditioning Means to Business

We have reviewed the possibilities of air conditioning with respect to the user. Let us now examine its economic possibilities as an industry from the standpoint of the manufacturer. Air-conditioning equipment is really an assembly of various types of mechanism. There is the air-conditioning chamber itself, using either heat-transfer surface or sprays, in which the air is either heated or cooled, humidified or dehumidified, and cleaned of dust or other impurities. There are many parts required from other manufacturers; air heaters or radiators; fans; pumps; cooling towers; and temperature and humidity control. In addition, there usually must be fabricated on the job sheet-metal ducts, either with or without insulation, for the distribution of the conditioned air; special registers and outlets for the admission of the air to the rooms; all of which must either be fabricated or applied on the job. Last, but the most important, is the engineering service required for the proper application of air conditioning to various requirements and to various types of building construction. Thus, it gives employment in many factories as well as in the field.

Every growing industry which has been carried over a number of years has a growing rate of doubling. The period for doubling in air conditioning is about every four years. The indications are that the future growth for some years may be expected to be as rapid as during the past seventeen years due to the fact that it is really an infant industry and there is a tremendous latent demand, as has been indicated. There is even a possibility that the rate of acceleration in growth will increase. But, on the assumption that the present growth alone may be maintained for the next twenty years, we may reasonably expect an industry of over $300,000,000 in 1952. From present indications, I believe it is apt to be greater rather than smaller.

"Within a few years the office building that is not air conditioned in summer as well as in winter will be wholly obsolete. If the addition of air conditioning will increase the occupancy 5 to 10 per cent, it will pay for itself without any increase in rental rates"

Translated in terms of employment from the mine or factory to the consumer, it means additional employment for over 500,000 people in the manufacture and installation of equipment, to say nothing of additional employment given to others in operation, maintenance and in power production. Annual power consumption corresponding to the cumulative sales of equipment would be more than one-sixth of the annual sales of equipment in the corresponding year, although the increase in power consumption for any year is less than 2 per cent of the corresponding equipment sales for that year. It is also a desirable type of load. The summer load is at present about 75 per cent of the winter load, while the air-conditioning load is predominately a summer load.

An addition of one-third to the present summer load would probably greatly increase the economy of operation and thus increase profits to the power companies as well as reduce the rate to users.

Flow Meters • • •

It has become necessary to measure process liquids, steam for heating and process, oil to furnaces, etc., to obtain savings . . . . Expensive changes in installed piping to permit accurate metering can be avoided by following the suggestions given here by Louis Gess*

EXPENSIVE changes in installed piping to enable accurate metering of the flow can be eliminated by the co-operation of the piping engineer with the meter engineer. When the piping is still in the blueprint stage, the latter can point out conditions which make accurate metering impossible, and offer suggestions to eliminate or nullify the effect of such conditions.

Use of Fluid Meters Increasing

The number of meters used for the measurement of steam, gas, oil, water and other fluids has greatly increased in recent years. Formerly, the majority were used only in central stations, or the power houses of the larger manufacturing plants. Today, however, this is no longer true; it has become necessary to measure all sorts of process liquids, steam to processes and heating, oil to furnaces, etc., in order that a strict accounting of cost may be kept; with information on cost, opportunities for saving can be determined. Fluid meters are now installed in laundries, dye plants, chemical plants, hosiery mills, foundries, steel mills, office buildings, and a host of other places throughout the industrial world.

A type of meter in general use in these plants is the *head* or *rate of flow* meter. This type makes use of a device known as a *primary* installed in the line to operate a *secondary,* which is the meter. The primary consists of an orifice, flow nozzle, or venturi, which creates an increase in fluid velocity, and a temporary drop in line pressure across the primary. This is known as differential pressure. Hereafter, the primary will be called the *orifice,* and the secondary the *flow meter.* Suitable pipe connections from either side of the orifice to the flow meter are provided for impressing this differential pressure on the flow meter for operating purposes. The flow meter is designed to record or to indicate the rate of flow, to totalize, or in some combination. Complete information is available in the several manufacturers' catalogs.

Fittings in Piping Affect Accuracy

The most important single factor affecting the accuracy of the meter is the relationship of pipe fittings, such as tees, bends, elbows, valves (globe, gate, butterfly and reducing) in reference to the location of the orifice. The ideal location for the orifice would be where there was an unobstructed flow through a straight pipe for a considerable distance on each side of the primary. Since such conditions are seldom obtained in practice, it has been found that satisfactory results can be obtained if the orifice can be installed under conditions as indicated in Fig. 1, provided that within 100 pipe diameters the piping in which the flow is to be measured contains nothing other than flanges, wide open gates or bends, elbows or tees, all in the plane of the pipe.

Straightening Vanes May Be Needed

If the above conditions are not possible, it may be necessary to install straightening vanes, Fig. 2, to eliminate the swirl which is set up in the line by the two ells in different planes. While a swirl may die out of its own accord, it may require several hundred pipe diameters of straight pipe to do so. A reducing valve, check valve, or pressure regulator upstream from the orifice plate will cause errors, which also may be eliminated by the use of straightening vanes.

Measuring Discharge from a Boiler

An ideal location for the orifice may usually be impossible to find in an installed piping system, or to make allowance for in the layout. An example of this is in measuring the discharge from a boiler into the main steam header. The usual piping arrangement is to have a loop which is a single length of pipe connecting the non-return valve on the boiler to the shut-off valve at the steam header. If the radius of the bend of the pipe is at least 6 pipe diameters, fairly satisfactory results will usually be obtained by installing the orifice at the joint between the pipe and valve. In this case, one pressure connection at the orifice is made in the body of the shut-off valve. This is only permissible when the shut-off valve is of the gate type.

If the piping is still in the layout stage, the installation can be made to give accurate results by the raising of the loop and the use of an extra flange for holding the orifice. Such an arrangement, Fig. 3, while adding to the cost of the installation, is justified by the more exact measurements that will be obtained. Note that the pressure connections are made in the plane of the bend in order that the pressure readings are not affected by the centrifugal forces set up by the steam flowing around the curved pipe.

Location of the Manometer

The location of the manometer is also important. It should be such that the manometer is not subjected to

* Flow Meter Engineer, The Brown Instrument Company, Philadelphia, Pa.

extremes in temperature changes, is accessible for the necessary maintenance and located as close to the orifice as possible. Extremes in temperature changes may cause the meter to read in error, and if freezing occurs, may burst the manometer. If access is easy, the necessary maintenance can be more easily done than if it is installed at a point where it is difficult to make calibration tests or periodic inspection. If the manometer is close to the orifice plate, the length of connecting pressure piping is reduced, and may frequently consist of a single length of pipe or copper tubing. The result is that the meter will be less sluggish and the possibility of leaks occurring at pipe joints is reduced.

Measuring the Flow of Steam, Liquids and Gas

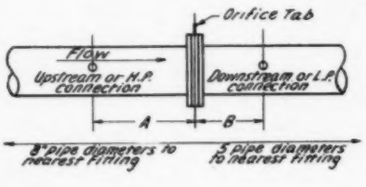
While in general the location of the manometer may be at any level with reference to that of the orifice, certain methods of installation are either more economical to install, or cause the meter to operate more satisfactorily. In the measurement of steam or liquids, the manometer and pressure connections are filled with water when measuring the former, and with the liquid being measured in the latter case. It will be found best to install the manometer below the level of the orifice, Fig. 3. An example of the floor mounting method for a mechanical meter measuring the flow of water is shown by Fig. 4, the meter being below the orifice. If the manometer is located above the orifice, the piping system becomes complicated, and in case of liquid meters the amount of maintenance is increased. It is advisable to obtain the recommendations of the meter engineer regarding the size of the connecting piping, location of vents, etc., for the latter types of installation.

If the gas or air is dry, the manometer can be located above or below the orifice plate. In either case, the orifice taps should be installed on top of the pipe. If the manometer is located below the flow line, the orifice piping should extend upward 6 to 8 ft, and then make a large radius bend down to the meter. If the gas or air is moist, it is best to locate the meter above the flow line in order that any condensation which may take place in the piping will drain back into the flow line. If the meter must be located below the flow line, suitable traps should be used to keep the liquid from entering the meter.

The Measurement of Pulsating Flow

The most difficult flow to measure is that which is pulsating. By pulsating flow is meant the flow of steam to a reciprocating machine, or the discharge from reciprocating compressors and positive displacement blowers. In either case, the pulsation may affect the accuracy of the meter even though the primary element is installed several hundred feet from the source of pulsation. While there is much experimental work still to be done on the measurement of pulsating flow, sufficient data are available to permit making corrective measures which will reduce the resulting error to within reasonable limits. The prospective purchaser of metering equipment should get in touch with any of the meter manufacturing companies, who will be glad to discuss the matter and determine if it is possible to reduce the error within allowable limits. The amount of error depends upon the rate of flow, the number of pulsations, and the distance which the primary element can be located from the source of pulsation. In general, the error may be reduced by the use of large volumes, or by the creation of an artificial pressure drop between the primary element and the source of pulsation.

Fig. 1 (Below)—An ideal orifice location



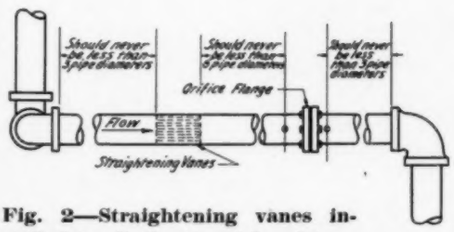

Should never be less than 3 pipe diameters
Should never be less than 6 pipe diameters
Should never be less than 3 pipe diameters
Orifice Flange
Flow
Straightening Vanes

Fig. 2—Straightening vanes installed to eliminate swirl and consequent inaccuracy caused by single turn in two planes

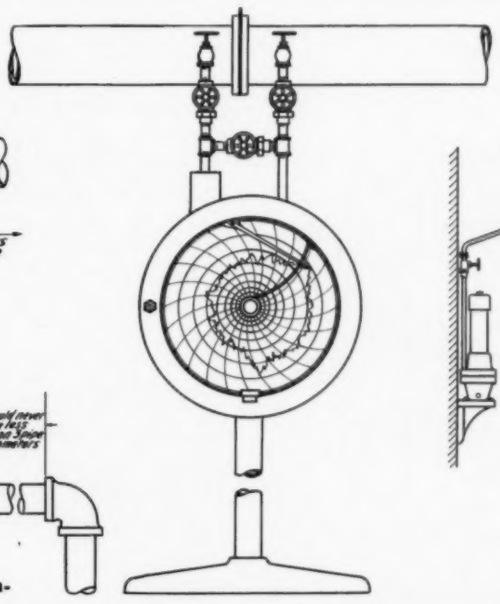


Fig. 4—Floor-mounted mechanical meter for measuring the flow of water

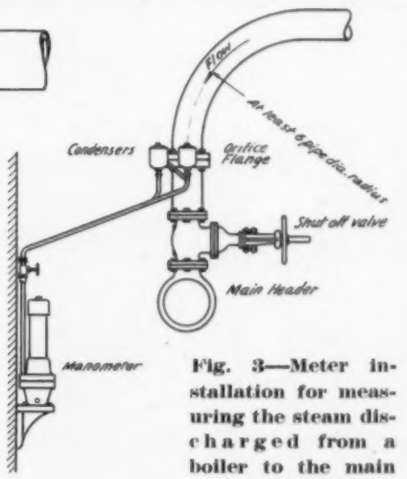
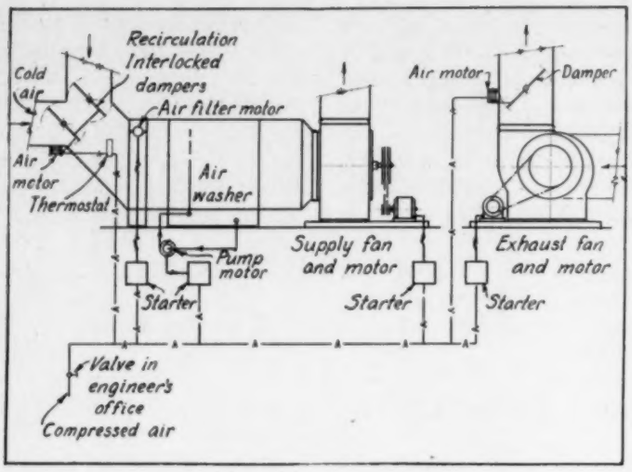


Fig. 3—Meter installation for measuring the steam discharged from a boiler to the main steam header

Compressed air — electric remote control of fan, motors, thermostat, intake and recirculating dampers, washer-pump motor and air-filter motor of an air-supply system distant from the engineer's office. The exhaust system corresponding to this supply system also is remotely-controlled and it is pneumatically interlocked



Many variations are possible and practical in the arrangement of control apparatus for motors driving ventilating fans. In the modern large building some form of centralized control is a necessity, as frequently ventilating and air-conditioning equipment is located in many spaces throughout the building. . . . . This article describes how motors for fans are controlled by means of electricity and compressed air.

The Control of Motors Driving Ventilating Fans

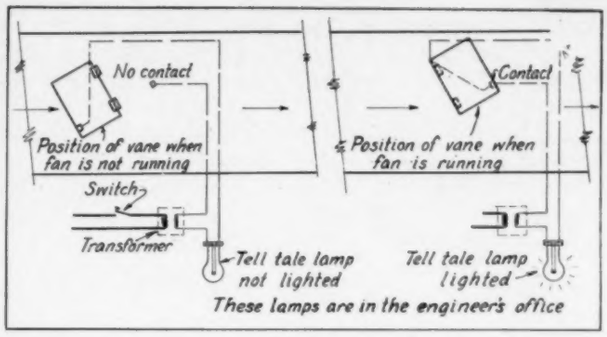
By . . . Samuel R. Lewis*

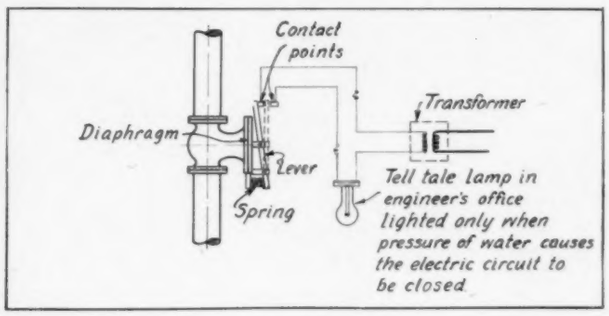
FANS are peculiar in that the energy requirements usually are very steady, with fluctuations in demand only when doors into the air-ways may be opened, or when starting up. Fans, like centrifugal pumps, require power in proportion to the work which is being accomplished and not in proportion to the speed, except, generally speaking, as friction of bearings and skin friction air resistance are concerned. If a fan wheel can secure no air to handle at any given speed, the power input for that fan will be at a minimum. If without changing the speed the fan can secure an easily-coming, easily-going, ample supply of air the power input will be at the maximum, and the electric motor which propels the fan easily may be overloaded.

Certain types of fans, therefore, must be provided with electric motors of from 25 per cent to 50 per cent greater capacity than ever will be needed for ordinary operation, so as to provide against danger of overheating, fuse blowing, etc., in the case (which may never happen) of a carelessly open door.

Some ventilating systems the writer has observed have several of these fans in the same room, all pulling from a single intake shaft, perhaps through a heater or air washer common to all. Ammeters showing the electric input to the motors driving fans so placed go crazy. First one fan grabs the major air volume, its motor tries to handle it, and slows down in the attempt; the other

*Consulting Engineer, Chicago, Ill.


No contact
Contact
Position of vane when fan is not running
Position of vane when fan is running
Switch
Transformer
Tell tale lamp not lighted
Tell tale lamp lighted
These lamps are in the engineer's office


Contact points
Transformer
Diaphragm
Lever
Spring
Tell tale lamp in engineer's office lighted only when pressure of water causes the electric circuit to be closed

fans race, and then perhaps one of them catches a load and so, hour on and hour off, the occupants of the building are subjected first to air floods and then to air famines.

Fans are now built with characteristics which resist this load-grabbing and over-loading tendency, and so electric motors with less excess capacity may be safely used. However, there is rarely an excuse for having several fans take air from a common source, especially when they discharge this air into ducts and rooms which have different volume and pressure requirements.

Tendency Is to Locate Fans Near Areas Served

The details of the actual control mechanisms for electric motors which propel ventilating fans are not especially different from those for motors which drive pumps. There is, however, a decided tendency in modern ventilating engineering to use remote control, and to use several fans in a building, each one near the area which it serves. A number of fans and electric motors and the necessary electric wiring and pneumatic piping to serve them may involve less investment cost and occupy less space than the large ducts which would be required with one relatively large fan supplying air to the entire building. In many cases advantage may be taken of the increased capacity and improved comfort and efficiency which follows the placing of a circulating fan adjacent to local heating surfaces, as with unit heating machines.

Cooling for comfort cannot be accomplished economically or efficiently without fans to drive the cooling air rapidly away from the heat-absorbing surfaces.

In one large Masonic temple there are a number of different departments, such as the club-restaurant recreation department, the auditorium, several different lodge halls, an armory, a ladies' department, etc. Only very rarely are all of these departments in use at the same time. Each department therefore is provided with its own separate air supply fan and exhaust fan; some of the departments have several fans. The fan chambers are located near the rooms they serve. By the combination use of compressed air and electricity, the controls and tell-tales are arranged so that the engineer can operate all the fans from one central point. The following is a typical hook-up for an installation of this kind.

Operations Which Must Be Remotely Controlled

It is desired to open the cold-air intake door from out-of-doors for any one of the systems, close the recirculating damper, open the outboard exhaust damper, start the air-washer pump, energize the air-filter motor, start the supply fan, and start the exhaust fan.

A pneumatic valve in the engineer's office is opened, sending compressed air at about 15 lb pressure to the supply-fan chamber and to the exhaust-fan chamber. The compressed air reaches a thermostat which regulates the proportion of cold air and recirculated air which is admitted to the fan, but which, when no compressed air seeks passage, causes the cold air intake to be closed tightly.

Above—Automatic mechanical-electrical tell-tale to insure operation of remotely located fan systems, which might not be delivering air for some reason even though an electric indication might show the motor circuit to be closed

Below—Pressure-operated tell-tale which will inform the engineer positively that the air-washer pump is delivering water, a more certain indicator than one which merely may certify to the engineer that the pump circuit is closed

The compressed air reaches three electro-pneumatic switches at the supply-fan chamber, one of which closes the air-washer pump-motor circuit; another closes the supply-fan motor circuit and the third energizes the air-filter mechanism. All of these switches are closed only as long as the compressed-air bellows holds them closed; all will open automatically if the air pressure fails. The closing of the pneumatic valve in the engineer's room and the release of the air pressure to leeward of this valve thus causes opening of the electro-pneumatic switches and restoration of shut-down conditions. A simple flap vane in the main air-way acts as a tell-tale which always will open a circuit when no air stream is passing it, but which closes a low-voltage circuit as long as the air duct is working. This circuit energizes a miniature lamp in the engineer's office, and shows that the supply fan is receiving air and is delivering it. A similar arrangement, actuated by a diaphragm in the pressure pipe leading from the air-washer pump shows that the pump is running and that water is available, and that the pump is primed.

The branch of the compressed-air pipe extends to the exhaust-fan chamber; by a similar electro-pneumatic switch compressed air, inherently interlocked mechanically with the supply-fan control, starts and stops the exhaust fan. A bellows, which holds open the exhaust-fan outlet damper while compressed air is present, assures that this damper is open while the fan operates

but is closed, preventing waste, when the system is shut down. A tell-tale lamp in the engineer's room shows that the outlet damper is open, since if it were not open, no air would be present to cause the flap vane to light the miniature lamp.

Starting Equipment for Fan Motors

For constant-speed squirrel-cage induction motors of across-the-line type, 30 hp and smaller in size, a starter consisting of a fused line switch and a magnetic switch, the latter actuated by a push-button stop-and-start switch, or an automatic pressure- or temperature-controlled switch, may be used. Overload and undervoltage protection are provided by suitable relays.

Squirrel-cage motors over 30 hp may have compensators for starting the motor under reduced voltage. This equipment may comprise, for each motor:

A fused line switch.

A starting resistor which is in contact with the power lines until the motor has been accelerated to full speed.

A line contactor.

An accelerating contactor.

An accelerating relay.

A temperature-overload relay.

The line contactor is actuated by a push-button switch, or by an automatic switch of the temperature- or pressure-control type. This connects the motor in series with the starting resistor and causes the accelerating relay to function. After the lapse of the time for which the relay is set, the accelerating contactor closes, short circuiting the starting resistor and placing the motor on the full line voltage.

Reduction of line voltage, or pushing of the stop-button or its equivalent, opens the line contactor, disconnecting the motor from the line.

Wound-rotor motors may have an external resistance in the secondary circuit for speed reduction. Hand controllers of this type are provided with rheostats for multi-step adjustment of speed. Automatic controllers for wound-rotor motors are provided usually with relays and contactors for short circuiting definite amounts of resistance in as many steps as there are provided push-buttons to energize the relays. These step-controllers are useful for centralized remote control when the motors so controlled are of variable speed.

The several push-buttons on the resistance relay circuits may be provided with indicating pilot lights for easy reading of the speed at which the fan is operating.

An additional control station at the fan may be provided for emergency use.

Thermal overload relays and under-voltage protection are provided with this type of starter.

For large fan motor loads (say of over 25 hp) synchronous motors are applicable, if power factor improvement is sought. A synchronous motor essentially is a constant-speed motor.

A starter for a synchronous motor should comprise:

A fused line switch.

Accelerating contactors operating from definite time relays which apply reduced voltage from a transformer to the motor during the accelerating period, and which provide under-voltage protection.

Line contactor which closes the motor to the line when synchronous speed has been reached.

A field relay-contactor which allows field excitation to be applied only when the motor has reached a speed near synchronism.

Temperature-overload relays which disconnect the motor from the line in case of an excessive current demand.

Line and field ammeters and pilot light for indicating values of current and when the line voltage is on.

Rheostat for regulation of field excitation.

Controlling Unit Ventilators in an Office Building

In a large office building which has exposures on all four major orientations, the ventilating is accomplished by local unit-ventilating machines, each of which takes cold air directly from out-of-doors.

There are ten of these machines on each side of the building. To open and to close the cold air intakes and to start the forty fans on each story every morning and to stop them every evening individually, would be impractical. It is desirable, if not necessary, to vary the time of operation of the fans on the various exposures as outside wind and temperature conditions dictate, and as occupancy conditions indoors prescribe.

The control of these electric fan motors therefore is arranged as follows for each of the four exposures for each of the many stories:

For example, the north units of the second story have an electric push-button switch in the engineer's office in the basement. This sends energy directly to the unit fan motors and to an electro-pneumatic valve which opens compressed air to the individual bellows of the ten cold-air intake dampers, forcing these to open and holding them open only as long as the fan motors are receiving electric energy. If the fan motors no longer receive energy the pneumatic valve closes, opening a leak port to leeward of the valve, and the springs on the cold-air intake dampers then force them to shut tightly against the weather.

There are, of course, many variations possible and practical in these remote motor-controlling functions of electricity and compressed air.

New Book on Industrial Temperature and Humidity Control

"The Handbook of Industrial Temperature and Humidity Control" by M. F. Behar, has recently been published by Instruments Publishing Company, Pittsburgh, Pa. ($4). It comprises parts 2 and 3 of the "Manual of Instrumentation." Consisting of over 300 pages, the volume is divided into two sections. The first, on temperature, contains chapters on temperature—general; indicating thermometers; thermoelectric pyrometers; radiation and optical pyrometers, pyrometric cones, etc.; recorders; automatic control; control instruments and accessories.

The second section comprises: humidity—general; measurement; humidity and aerological measuring instruments; automatic control. Each topic is covered in considerable detail and numerous tables complete the work.

Industrial Management Described

In "Industrial Management in this Machine Age," Francis A. Westbrook describes how modern plants are organized and operated. Through personal experience and contacts with factory executives the author has secured a number of actually-used methods which he explains, compares, and analyzes. The book is intended to appeal primarily to the student of economics or management, and to the plant manager desiring to keep in touch with current practice. Engineers in industrial organizations will find several of the chapters particularly interesting, among them being the section devoted to organization and functioning of the engineering department, plant maintenance organization and functions, scientific research and technical control, and inspection.

The industries chosen as examples represent a wide range of products, the principles and practices described applying to both small and large concerns.

The book is published by Thomas Y. Crowell Company, New York City ($3.50). It consists of about 400 pages, the text being well-supported by organization charts.

Text on Automatic Refrigeration Control

"The Automatic Control of Refrigeration", by H. T. Lange and A. B. Schellenberg has been published by Alco Valve Company, St. Louis, Mo. ($1.50). It is a discussion of some of the important control devices, and is confined to those devices which control the refrigerant.

The book consists of 100 pages (paper covers) divided into the following chapters: Introduction; filtration; constant pressure type expansion valve; thermostatic expansion valve; high-pressure float valve; electrically-operated valves; automatic control of circulating brine; automatic control of unit coolers; electrical wiring diagrams. The book is amply illustrated and carefully indexed.

• • • • MODERNIZE

Heating, Piping and Air-Conditioning Systems

FOR EFFICIENCY AND ECONOMY • • •

Plant and Building Heating Systems

Check-Lists Aid Proper Maintenance

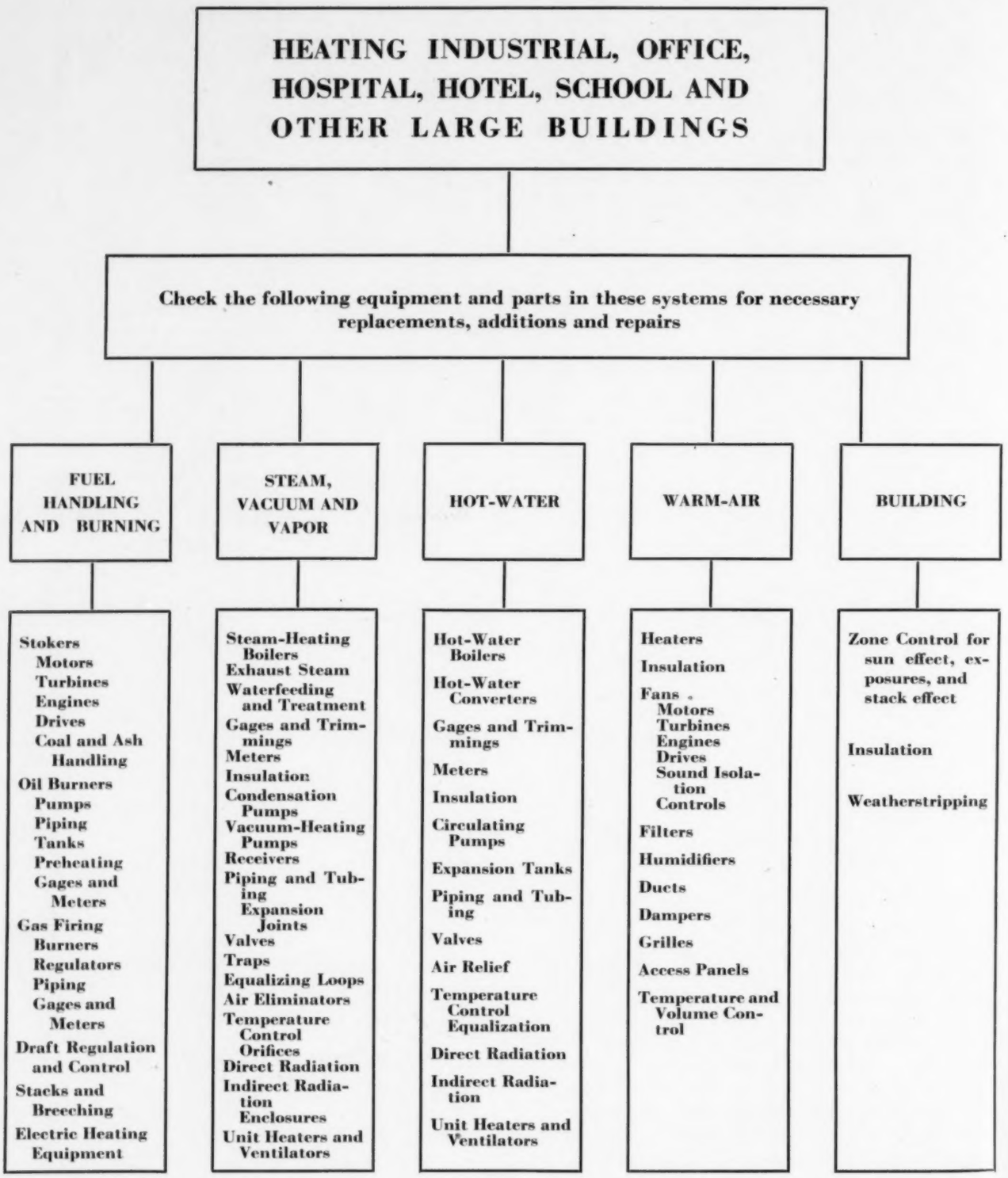
Heating systems in plants and large buildings offer a wealth of opportunity for saving money through proper maintenance and repair and carefully-planned modernization and rehabilitation work. Heating is an indispensable service in every building. Naturally, it costs money—but excessive operating cost because of inefficient equipment poorly maintained or obsolete equipment which could be replaced by new equipment is wasteful and entirely unnecessary. Not only should present equipment be checked, but the advisability of replacement or additions should be considered.

The check-chart and maintenance guide on the following pages suggest the points where waste occurs in steam, vacuum, vapor, hot-water, and warm-air heating systems and in systems in buildings served by district steam. The check-list questions have been compiled by four authorities* on the four subdivisions and represent wide experience in locating the points in heating systems which often need attention. Because all types of heating systems are primarily for the same purpose, some duplication exists in the questions under each heading.

Using this check-chart and maintenance guide in checking a heating system will in the majority of cases lead to economy and increased efficiency.

*Steam, Vacuum and Vapor—Samuel R. Lewis, Consulting Engineer; Hot-Water—Erwin L. Weber, Consulting Engineer; Warm-Air—Platte Overton, Consulting Engineer; District Heating—Sterling S. Sanford, The Detroit Edison Company.

Modernize Heating, Piping and Air-Conditioning Systems for Efficiency and Economy—Check-Chart for Heating Systems



Check the equipment and parts which need attention. Replace with new, modern equipment where replacements will benefit; repair where repairs will suffice.

Maintenance Guide for Heating Systems

Check the chart on the opposite page for equipment and parts which require attention. Find below suggested maintenance and repair operations:

Steam, Vacuum, and Vapor Heating Systems

Boilers, Breechings and Stacks

Clean out bottom of stack? Check cleanout door for tightness with candle? Check cracks in stack and boiler setting with candle and point up? Sight up stack with aid of mirror for loose bricks, impediments, etc.? Check balance draft damper?

Breeching corroded or loose joints with boiler or stack, clean out breeching?

Boil sample of boiler water to test for cleanliness? Clean out mud legs of boiler?

Grates warped or burned?

Check safety valve—fusible plug—steam gage?

Clean gage glass and sediment from piping connections to boiler?

Check tightness of blow-off valve and water feed valve or automatic water feeder?

Test flaps in check valves?

Repair boiler and breeching insulation?

Check domestic hot water heater connections and clean out sediment from piping?

Is there adequate air supply to boiler room for combustion?

Pumps

Clean sediment strainer?

Test vacuum with valve at inlet closed, and set vacuum switch?

Check float switch?

Check bearings and packing?

Oil motor?

Is thermometer on return line near pump to indicate return water temperature desirable?

Piping

Are pipe hangers pulled out or mains and branches wedged out of proper grade?

Are floor and ceiling plates tight?

Are expansion joints tight and packed? Guided properly? Anchors tight?

Clean dirt pockets in mains and loops in returns?

Repair insulation? Install steel jacket where insulation is subjected to damage?

Are gaskets in flanged connections whole and bolts tight?

Are there any rises in piping that are undrained? Are all steam mains adequately vented and drained?

Is buried piping drained and dry? If corroded, replace? Can it be run above ground?

Are high-pressure drips joined to high-pressure return, or provided with a flash chamber where connected into low-pressure return?

On vapor piping system, is a check valve provided on a connector between the steam and return mains set to open if pressure on steam side falls below that on return?

Pressure Reducing Valves

(See Steam Piping Check-list, October issue)

Steam Traps

(See Steam Piping Check-list, October issue)

Radiators, Valves, and Traps

Have floors settled to affect radiator drainage?

Do both steam and return pipes pitch away from radiator?

Is radiator air bound? Does air-removing device function? Are blast coil sections having different condensing rates trapped separately?

Is each radiator installed so as to permit free air circulation around it?

Are valves tight? Stuffing box need packing? Seats and discs O. K.?

Are temperature-control valves provided with hand valves on steam pressure side? Is there drainage when temperature-control valve is closed?

Is it the right trap for the service? Is trap overloaded during heating up period?

Is thermal element broken or corroded? Volatile liquid missing?

Should a cooling leg be provided ahead of trap?

Does trap disc meet seat all the way?

Hot Water Heating Systems

Boilers

Thoroughly inspect boilers for leaks and defects?

Inspect furnace and close up all air leaks?

Inspect, clean and adjust stokers or oil burners?

Check thermostatic control system?

Check altitude gage and thermometers?

Check expansion tank and see that vent line is open?

Check domestic hot-water heater and connections?

Piping

Check piping thoroughly for leaks?

Check for proper air relief?

Re-align piping to avoid any air pockets?

Is piping laid out for zone control and can south side be throttled for heating effect of solar radiation?

Provide thermometers on zone return lines?

Provide dirt pockets at bottoms of down-feed risers?

Clean all dirt pockets and strainers

Make sure expansion line cannot be closed by any valve?

In closed tank systems, check safety valves?

Check all automatic feeders, etc.?

In open tank systems with insufficient radiation and with expansion line taken from flow riser, change expansion line connection to return main to permit of carrying higher temperatures, arrange piping for complete air relief?

In overhead systems with expansion riser on return main, check overhead distribution mains, and if same pitch downward from supply riser, change to pitch upward and provide automatic air relief valves on ends of mains? Use eccentric reducers?

Radiation

Check all radiators and valves for leaks?

Pack all leaky valves?

Relieve all air at radiators, etc.?

In under-radiated systems with bronzed radiators, apply paint?

Pumps

Clean pumps and motors or turbines?

Tighten packing glands?

Examine by-passes?

Provide sound isolation bases?

Remove any vibration or knocking?

Take up bearings, wash out?

Convertors

Clean convertors thoroughly?

Test for leaks and air relief?

Maintenance Guide for Heating Systems—Continued

Check steam and return lines, traps, etc., as for steam systems?

Circulation

Check equalization of circulation with all radiator valves fully opened, preferably with thermocouples or equally reliable means?
Provide means for accurate equalization?
Throttle flow to radiators receiving too rapid a circulation?
Check for reverse circulation?
Provide larger pipe or extra lines to radiators which cannot be made to circulate satisfactorily?
Where local return circulation exists in a flow (or return) main provide an anti-circulation (running) trap in that line?

Operation

Prepare operating schedule of temperatures to be carried for various outdoor temperatures and allowances for wind movement and solar radiation?
Provide blanks for engineer's report on operation?

Buildings Served with District Steam

Main Valves

Do valves seat tightly?
Are valves accessible?
If valves cannot be reached from floor, are they equipped with sprocket wheels and chains or other means for convenient operation?

Pressure Reducing Valves

Can setting of heating system reducing valves be easily changed?
Can the valve serving the direct radiation be used for reducing from pressure to vacuum? If not, can it be rebuilt for this service?
Are water heaters, blast heaters, etc., served independently of the direct radiation?

Mains

Are the mains arranged so that the heating system can be operated independently of all other uses for steam in the building?
Are there separate mains to water heaters, sprinkler-tank heaters, blast heaters, kitchens, laundries, etc?
Are there separate mains to places in use for long hours such as first floors, lobbies, restaurants, drug stores, telephone switchboards, etc.?
Are there separate mains to places having short-hour use such as auditoriums and ballrooms?
Separate mains to offices in plants, garages and warehouses?
Is building zoned for sun, wind, and stack effect?

Risers

Are risers of proper size?

Radiators

Are radiators sized so that building heats evenly
Are radiators in upper part of tall buildings larger than necessary?
Is circulation of air to radiators obstructed by building fixtures?

Temperature Control

Is heating system equipped with some means of controlling building temperature such as radiator orifices, automatic intermittent control, high vacuum equipment, thermostats, etc.?
Is control equipment properly adjusted?

Instruments

Are pressure gages of the compound type?
Is building equipped with a remote-reading thermometer system?
Are water heater and economizer equipped with thermometers?

Fan System

Is system arranged for maximum recirculation of air when possible?

Vacuum Pumps

Will vacuum pumps produce proper vacuum?

Traps

Are all two-pipe radiators equipped with thermostatic traps?
Are traps inspected and cleaned every year?
Are all drip traps accessible?
Do all drip traps have sufficient capacity?
Do drip traps have valves ahead of them?

Water Heaters

Is temperature control set for higher temperature than necessary?
Are coils free from leaks and in good condition?

Economizers

Is economizer large enough?
Are coils free from leaks and in good condition?
* Does the hot-water recirculating line tie in between economizer and water heater?...?

General

Are windows tight and properly weatherstripped?
Is all piping in building protected to prevent freezing when steam is shut off at night?

Warm-Air Heating Systems

Furnaces

Make flue gas analysis?
Take draft reading?
Examine draft doors for tightness?
Draft control thermostat functioning?
Install indicating thermometers in plenum chamber to check temperatures?
Flues clean?
Inspect heater casting for cracks or leaks?
Air from fan reaching all parts of heating surface?
Is firing done properly to maintain heat uniformly over entire heater?
Heater smoke breeching clean? Proper size and design? Insulated?
Cut-off louvers in rear of heaters? Working properly? Automatic in action to prevent over-heating of furnace?
Plenum chambers insulated?
If fuel used is oil, proper brick arches installed in furnace?
Heaters in battery set too close or too far apart?
Install partitions between heaters?
Check grates and fire box liners for warps or breakage?
Elevate heaters above floor to allow air to pass under ash pit?
Clean dust from castings and plenum chambers?
Check Btu produced against Btu fired? (If efficiency is below 50 per cent, investigate and correct)?
Check opening from plenum chamber to ducts for abnormal pressure loss?
Check heater foundations to see that settling will not throw undue strain on castings?
Inspect humidity pans to prevent them overflowing on hot castings, causing breakage?

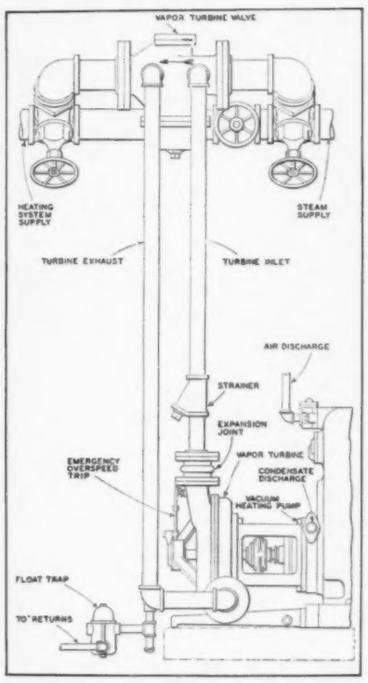
Fans, Filters, Ducts, Etc.

(See Air-conditioning Check-list in November issue)

INTERESTING Equipment..... Developments

DRIVEN by a vapor turbine which takes steam from the supply mains and returns that steam to the heating system, the vacuum heating pump recently announced by Nash Engineering Company, South Norwalk, Conn., and illustrated here is aimed to promote economy in heating systems. The turbine operates on a differential pressure of 2½ lb and can be applied to systems operating above or below atmospheric pressure. An electric standby unit with complete automatic control by vacuum and float is incorporated. The capacity of both pumps can be utilized under peak load conditions; the electrically-driven unit will automatically cut in when the steam supply is insufficient to operate the turbine or may be used when it is desired to inspect the turbine or valve.

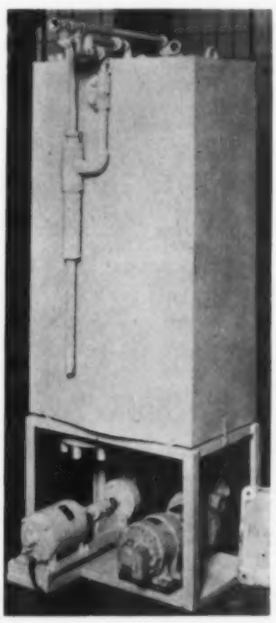
The vapor turbine valve maintains the correct differential pressure for operation of the turbine, by-passing the correct amount of steam to the turbine under various load conditions. The heat given up by the steam passing through the turbine is equivalent to 2½ lb expansion or about ¾ of 1 per cent of the total heat of the steam. The valve is equipped with a dash-pot for smooth operation and the entire interior can be removed without taking the body from the line.



Condensate and air are handled by separate pump elements, and ratings are given for maximum condensate capacity at the same time the pump delivers its maximum air capacity.

Cools Water With Steam

A STEAM-JET refrigeration unit recently shipped by the Ross Heater & Mfg. Co., Inc., Buffalo, N. Y., is shown here and is suitable for industrial processes requiring water at a temperature between 35 and 60 F, supplying cold water for air conditioning, or for cooling drinking water.



The unit operates on low-pressure steam at 12 lb gage pressure and has a refrigeration capacity of 2½ tons when supplying 50-F water. Units of the same type are available to operate on any available steam pressure from atmospheric up, in capacities from 2 to 20 tons. Units larger than 20 tons are made of a horizontal type with the same principle of operation. Vacuum steam units operate on exhaust or street steam, or steam direct from boilers.

New Valves for Temperature Control

A RECENT addition to an electric system of temperature control includes a line of small electric-motor-operated throttling valves, designed for service where graduated valve action is required. They are especially useful on small blast systems and air-conditioning systems where throttling valves smaller than the 2-in. size are needed. Unit heaters and unit ventilators which require a throttling control can also make good use of them. The valves are available in packed or packless models, high or low-pressure types, sizes from ½ to 2-in. The Barber-Colman Company, Rockford, Ill., is the maker. The motor-operator used is a small reversing damper controller mounted on a special bonnet. The motor-

operator turns a cam which imparts a positive longitudinal motion to the plunger sleeve that fits over the valve stem. Since a "reversing" type operator is used, it can be stopped, restarted in the same direction, or reversed at any position between the points where the valve is fully open or fully closed. The speed is adjustable after installation, and consequently can be changed to meet varying requirements. Auxiliary "training" switches are incorporated in the motor-operator and from these switches it is possible to actuate other apparatus such as the subsequent valves on a blast system.

Also recently announced by this company is the addition of a line of three-way valves arranged to be opened and closed by an electric motor-operator unit mounted in place of the customary hand-wheel. They are of the conventional three-way type, available in sizes from ½ to 2-in. with either positive or reversing operators. The "positive" operator is for use in installations requiring a complete changeover from one to the other of the two paths through the valve. The "reversing" operator is for use in mixing service where the two inlets are to be partially opened as required to give throttling action.

The valves are suitable for use in various processes requiring three-way valves, for mixing valves on fluid tanks, on spray-type humidifiers, and in any place where it may be required to wholly or partially discharge one or both of two sources into a common outlet or to divide the output from a single source all into one or partially into both of two outlets.

The valves may be controlled from a manual or automatic switch or a thermostat. Power required is 25-volt, 60-cycle; any control source which will handle this input will govern the valve action.

Cleans Heating Boilers

MECHANICAL cleaning of heating boilers is accomplished by a soot blower system available for both fire-tube and water-tube types. Maintaining clean heating boiler surfaces semi-automatically saves fuel and reduces the tendency for the job to be slighted.

The illustration shows an installation of the water-tube boiler type. The system consists of a motor-driven air compressor, an air storage tank, a pressure-actuated switch, and, for each boiler, one controller with switch, one electrical interrupter for timing the duration of each blow, one air control valve, the required number of soot blower units, and connecting pipe, valves, fittings, and wiring.

Operation consists of the pressing of a push button, the opening of the air control valve and the closing of the controller switch to No. 1 boiler. From this point, blower operation is automatic. When pressure in the air storage tank reaches 120 lb, the first blower unit begins operation. This unit continues to rotate in steps and blow in puffs as long as pressure remains between 80 and 120 lb, or until it completes its blowing arc. When pressure drops to 80 lb, blowing ceases until the compressor again builds up the pressure in the storage tank to 120 lb. When the first unit completes its blow, it is automatically cut out by the controller and the second unit is cut in. This continues until each unit has been operated, when the blower system for the first

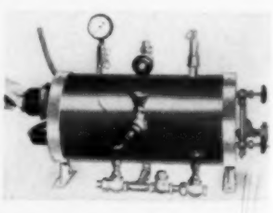
boiler shuts down. Each succeeding boiler is similarly cleaned.

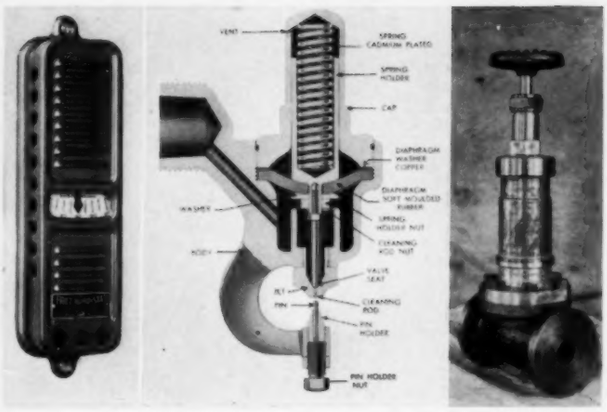
Diamond Power Specialty Corporation, Detroit, Mich., is the manufacturer.

Generate Process Steam

MINIATURE steam generators, electrically-heated, are now available from the Commonwealth Electric and Manufacturing Co., 83-107 Boston St., Boston, Mass., in 2, 3, 4, and 5-kw sizes. These new steam boilers complete a line in capacities from 2 to 90 kw (1/5 to 90 boiler hp).

The four new sizes correspond to 6, 9, 12, and 15 lb of steam generated per hr, at gage pressures from ½ to 100 lb. Either alternating or direct current may be used. The units are ready to connect for use in supplying process steam for manufacturing or research and are semi-portable. Their use often enables piping economies.





For Accurate Humidity Control

ACCURACY of operation is a feature of a new humidostat for automatic control of humidifying, dehumidifying, drying, etc., and made by Julien P. Friez & Sons, Inc., Baltimore St. and Central Ave., Baltimore, Md. This new control is of advantage in industrial applications, tests indicating effectiveness in very high humidities. The instrument is made in two forms, one for use in rooms (see left view above) and the other for insertion in ducts, drying machinery, ovens, incubators, and the like.

The hygroscopic element is human hair properly selected, mounted, treated, and calibrated. Each element consists of 54 hairs, and the manufacturer states they remain in good working order indefinitely and are unaffected by temperatures of 175 F.

The instrument is ordinarily used as a 3-wire instrument in conjunction with a suitable relay, but may be used to make a pair of contacts at a desired high or low humidity. The contacts will carry up to 25 watts at 110 volts.

A pointer and scale are provided for setting the instrument.

Humidifier Nozzle Cleans Self

AIMED to eliminate costly cleaning of humidifier nozzles and consequent interruption of service is the recently-announced self-cleaning humidifier nozzle pictured above. Cleaning is accomplished each time the water supply is shut off, either by hand or automatic control. With water pressure on, that pressure acts on the diaphragm to reverse its natural position, lifting cleaning pin from the orifice channel. With water pressure relieved, the diaphragm assumes its natural position, forcing the cleaning pin into the orifice channel to carry accumulated dirt and foreign matter to the face of the orifice, where it is picked up by water upon resumption of water pressure.

A valve effect which operates to prevent dripping of any free or spent water from the nozzle when the water is cut off is incorporated. By a tapered facing and seat on the pin and in the jet, a valve construction is affected which arrests water delivery. Another improvement in the device is that the yoke which carries the impinging pin is of rugged construction and the fixture machined so that pin at all times is exactly opposite the orifice, assuring a continuous, controlled water spray of correct distribution and quantity.

The maker is American Moistening Company, 260 W. Exchange St., Providence, R. I.

Compensator Features Oil Relief Valve

PRINCIPAL feature of a new fuel oil and lubricating oil relief valve is the compensating mechanism interposed between the sliding plug and spring plate. It consists of three links mounted on a link bracket, 120 degrees apart around the vertical spindle. The ends of the links bearing on the plug and spring plate are fitted with hardened rollers, the centers of which are so located that during the vertical movement as the valve opens or closes the horizontal distance between the fixed center and center of the lower roller remains practically constant while the corresponding distance between the fixed center and the center of the upper roller changes. This variation of leverage compensates for the increased tension of the spring as the valve lifts and the resultant spring pressure is equalized throughout the stroke of the valve disc to insure close regulation of pressure. The screw spindle permits adjustment of the pressure from 15 to 600 lb (see right view above).

The valve is recommended as a by-pass valve in the fuel-oil burner line and on lubricating-oil systems where constant pressure is desired. It is built in globe and angle type bodies with operating mechanism totally inclosed.

Schulte & Koerting Company, 12th and Thompson Sts., Philadelphia, Pa., is the manufacturer.

New Trailer-Type Welder

A NEW engine-driven, 300-ampere arc welder of the high-speed portable trailer type uses a shunt induction principle for arc stabilization, aimed to permit high efficiency, greater metal deposit and little operator fatigue.

The mounting of the horizontal radiator directly over the engine, with blower-type fan, effects the cooling of the entire unit. A sliding cover over the radiator allows for proper amount of radiation and cooling regardless of temperature conditions.

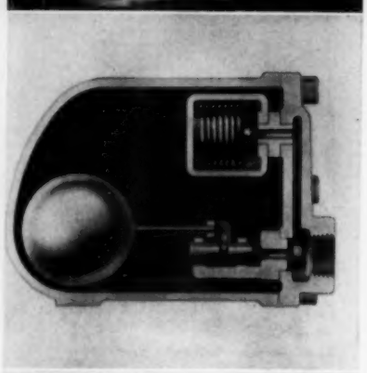
Uses of the welder include pipe-line extension and general maintenance work.

The manufacturer is Universal Power Corporation, 12367 Euclid Ave., Cleveland, Ohio.

Motor Is Splash Proof

A SPLASH-PROOF motor designed to prevent entrance of water splashed with terrific pressure from any angle, yet adequately ventilated and built in the same dimensions as standard open motors, has been perfected by The Louis Allis Co., Milwaukee, Wis.

A double baffle in an elliptical-shaped air passage in each endbell provides the protection. This construction, permitting free passage of ventilating air, traps and drains water splashed into the air openings at the bottom of the elliptical chambers. Another feature is a shaft guard which breaks the force of a stream directed along the shaft extension and prevents water from entering the bearing chamber.



The illustration shows one of eight tests in which the motor, while operating at 1800 rpm, was subjected to direct streams and water splashed from various angles. An inspection immediately following these tests showed the winding and inside of the motor to be dry.

Float Trap for Risers, Small Mains

APPLICABLE to risers, small mains, unit heaters, etc., the new float trap made by the Sarco Co., Inc., 183 Madison Ave., New York City, has an integral thermostatic air bypass inside the trap. All the working parts are mounted on the cover and are exposed for service by removing the trap cover.

The inlet and outlet on the cover are 2⅝ in. apart for horizontal piping and easy installation where head-room is limited. The valve head is spherical, designed to provide maximum capacity.

New Pumping Units

A MOTOR-PUMP unit for air washers, filters, brine circulation, transferring oils or chemical solutions, hot or cold water circulation and general industrial applications has been announced by the American Steam Pump Company, Battle Creek, Mich. Capacities range from 5 to 90 gpm for heads up to 120 ft and up to 450 gpm for a head of 60 ft.

The pumping unit is of a single-stage, single suction centrifugal type; the motors range from 1/6 to 10 hp and operate at speeds of 1,750 and 3,500 rpm.

Solenoid Water Valve Saves Current

SOLENOID water valves for use in air-conditioning work are made for ½-in. and ¾-in. piping. The first has a capacity of 600 gph at 45 lb pressure and the second a 1,350-gph capacity at 45 lb. Current consumption is 15 watts per hr. Automatic Products Company, Milwaukee, Wis., makes this valve.

In operation, a small part of the water entering the inlet side of the main valve passes up through a pilot valve in the unit and exerts the necessary pressure on a diaphragm which operates the main valve. The solenoid coil therefore operates only the pilot valve. Area of the pilot seat is 3/32 in.

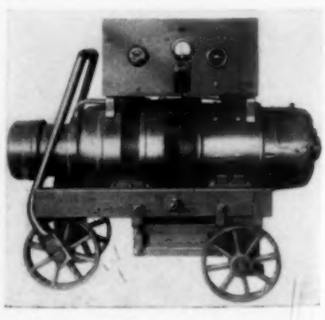
This company has also announced a humidity regulator and a pressure regulator and strainer.

Welder Has Dual Control

DUAL control for close regulation of the welding heat, separate excitation for quick recovery, reverse polarity switch for changing leads and use of a rubber mounting to eliminate vibration are among the features of a new arc welder in sizes from 100 to 800 amperes in motor-, gas-engine-, and belt-drive types.

The "dead front" control box, located at convenient working height, contains the motor start and stop buttons, current range switch, voltage control, and the reverse polarity switch on the front face.

Imperial Electric Company, Akron, Ohio, the manufacturer, emphasizes that it is easy to strike the arc and hold it in difficult places with this new machine, making it useful in connection with welding requiring particular skill. The distributors are Bryant Machinery & Engineering Company, 400 W. Madison St., Chicago.



• • • Recent Trade Literature

Compressors: The Vilter Manufacturing Company, Milwaukee, Wis. 12-p. bulletin. Rotary compressors for booster service; applications; typical layout; features; construction; dimensions.

Condensers: Ingersoll-Rand, 11 Broadway, New York City. 36-p. booklet. Installations of surface condensers; single- and two-pass construction; heart-shaped shell; external air coolers; longitudinal steam distribution; tube-sheet arrangement; small, steel-plate and marine condensers.

Convectors: Rome Radiation Company, Rome, N. Y. 20-p. booklet. Box fin and tubular types; construction; capacities; clearances; assemblies; installation data; enclosures; general information.

Drives: Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Calculator dial for selecting proper V-belt drive, showing driving and driven speed, number and size of belts, diameters of driving and driven pulleys, center distance, hp., catalog number and price.

Drives: The Dayton Rubber Manufacturing Company, Dayton, O. 32-p. catalog. Design and manufacture of V-belt drives embodying series of tooth-shaped corrugations on inner surface of compression section; tables for selecting proper drives; pulley dimensions and weights; special drives; general data; list prices.

Heating Pumps: Nash Engineering Company, South Norwalk, Conn. 12-p. booklet. Vacuum-heating pump driven by vapor turbine; auxiliary motor drive; construction; operation; sizes; dimensions.

Humidifiers: Southworth Machine Company, Portland, Me. 12-p. booklet. Controlled humidity in the textile industries; cotton; weaving; wool manufacturing; silk mills; knitting mills; relative humidity and its control; tables. 20-p. booklet. System of humidifying lithographing and printing plants; requirements and benefits; paper conditioning; humidifier and automatic control.

Hygro-Thermographs: Julien P. Friez & Sons, Inc., Baltimore St. and Central Ave., Baltimore, Md. Price sheet. Instrument used by air-conditioning engineers in making surveys, for research and tests; instruments for measuring temperatures in Fahrenheit or Centigrade; humidities from 0 to 100 per cent.

Meters: Bailey Meter Company, Cleveland, O. 24-p. bulletin. Fluid meters for steam and water; description; features; meters for low pressures; installation.

Meters: Builders Iron Foundry, Providence, R. I. 4-p. bulletin Continuous long-distance meter recording demonstrated; operation; uses.

Paint: National Lead Co. 12-p. laboratory bulletin. Increasing factory efficiency by the proper use of paint; principles; examples. 10-p. laboratory bulletin. Identification of piping systems; classifications; instructions.

Process Industries Equipment: Edge Moor Iron Company, Edge Moor, Delaware. 8-p. bulletin. Special equipment for the process industries fabricated from steel and alloy metals; tanks; fractionating towers; tube nests; kettles.

Pumps: De Laval Steam Turbine Company, Trenton, N. J. 4-p. reprint. Efficient suction head for centrifugal pump operation; head required on suction for satisfactory operation at various liquid temperatures.

Pumps: Worthington Pump and Machinery Corporation, 2 Park Ave., New York City. Three 4-p. bulletins. Deep well pumps for small capacity 6-in. wells; 6, 8, and 10-in. diameter wells; 12, 14, 16, and 20-in. diameter wells.

Pumping Units: Pennsylvania Pump & Compressor Company, Easton, Pa.; 12-page bulletin. Single-stage centrifugal pumping units for floor, ceiling, horizontal wall and vertical wall mounting; one shaft serves pump and motor; capacity tables; characteristics curves; construction features.

Refrigeration Systems: Foster Wheeler Corporation, 165 Broadway, New York City. 12-p. bulletin. Vacuum refrigeration; advantages; applications; operation; fundamentals; air conditioning; cooling food products; cooling towers.

Steam Storage: Ruths Steam Storage, Inc., New York City. 50-p. loose-leaf book. Steam storage in industrial plants; profit and production; the system; theory of accumulator performance; typical pressure charts; effect on boiler operation; field of applications; the regulator; descriptions and layouts of a number of installations; results.

Steam Traps: Armstrong Machine Works, Three Rivers, Mich. 28-p. book. Use of steam traps; inverted-bucket steam traps; features, construction, types; determining size of trap required; special problems; examples; calculating rate of condensation; drainage systems; individual traps; installation and maintenance; trap troubles; other uses (compressed air, separating two different liquids, air or gas relief, refrigeration); properties of steam; pipe dimensions.

Turbines: De Laval Steam Turbine Company, Trenton, N. J. 4-p. reprint. Installation of 1,000-kw turbine exhausting at 29-in. vacuum and bled for building heating described.

Valves and Fittings: Kerotest Manufacturing Company, 2525 Liberty Ave., Pittsburgh, Pa. 48-p. catalog. Forged brass valves and fittings for mechanical refrigeration; packless valves for air conditioning and commercial installations; specifications and standards for various types of valves; dryer; liquid indicator; strainers; fittings.

Ventilators: H. S. Kaiser Co., 936 W. Chicago Ave., Chicago. 6-p. folder. Filter-ventilator for installation in windows; features.

Warm-air Heating: Dail Steel Products Company, Lansing, Mich. 8-p. and 4-p. bulletins. Heating and air-conditioning equipment for supplying heated, washed, humidified and filtered air; units for plants, apartments, schools, stores, etc.; data and specifications.

Wrenches: Lowell Wrench Co., Worcester, Mass. 4-p. bulletin. Two-foot steel wrench guaranteed not to break; other types of wrenches.

ON THE JOB

. . . a department devoted to short, practical articles on the installation, operation and maintenance of air conditioning, heating and piping equipment . . . . . .

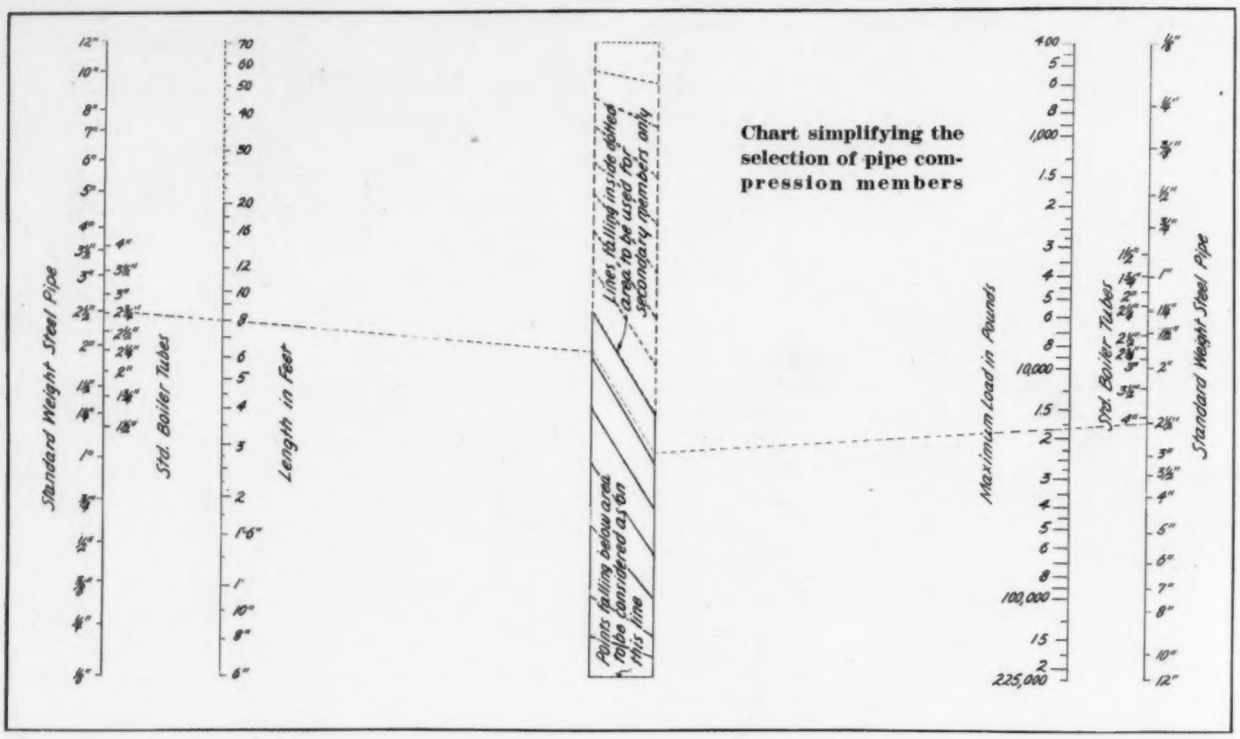

Standard Weight Steel Pipe
Std. Boiler Tubes
Length in Feet
Lines falling inside dotted area to be used for secondary members only
Points falling below area to be considered as on this line
Maximum Load in Pounds
Std. Boiler Tubes
Standard Weight Steel Pipe

Chart simplifying the selection of pipe compression members

Using Pipe for Columns

. . . . .By M. Barry Watson*

RECENTLY[1] the author discussed the use of standard-weight iron piping for beams, or structural members carrying transverse loads, for small or temporary work; a chart was published by which calculations for such uses of pipes could be made rapidly and mechanically.

The chart with this article is equally useful in designing pipe *compression* members such as columns, posts or struts. It is based on the column formula standardized by the *American Institute of Steel Construction.*

Pipe columns must be cut perfectly square on the ends, and must be supported on a perfectly flat surface. In lieu of this they may be threaded into extra-heavy cast-iron fittings, provided the threads are straight and clean. The simplest floor bearing consists of a screwed floor flange set on a bed of cement and sand after the framework is set up, to distribute the load evenly.

The accompanying chart requires two operations, whereas that for beams requires only one. The reason is clear when it is considered that the only variables in the flexure formula are length, load and section modulus, which produce a straight-line formula. In the case of columns, however, the variables are length, load, cross-section and least radius of gyration of the pipe. Since the last two quantities are not functions of one another, it is necessary to use two different scales of pipe sizes on the chart, one to limit the maximum length of column, and one to limit the load. These two variables are then related graphically by means of the center converting scale.

In order that the maximum allowable stress for short columns be not exceeded, the center scale must not be extended below the level given on the chart. For main members the center scales in full lines only

* Consulting Engineer, Toronto, Canada.

[1] See p. 667, October, 1932, HEATING, PIPING AND AIR CONDITIONING.

may be used; but for secondary members such as cross bracing, the dotted or broken line portion of the center scales may be used.

For an example of the use of this chart in designing, we shall continue the problem which we discussed in the case of beams, viz., a pair of frames for a 12 ft long, 42-in. diameter steel tank full of water. The load on each cross beam was found to be about 4,600 lb, and a 4-in. pipe cross member was found necessary. The end reactions of these beams were 2,300 lb each, which is the load on each leg or column. Assume a length between supports of 8 ft (i. e., height from floor to cross member).

Using the left-hand side of the chart, join the *8* on the length scale to the top of the solid line section of the center scale. This line produced to the left indicates that a pipe column this long must be larger than 2-in. standard pipe, or 2½-in. boiler tube.

We now must check up the load which the next larger pipe, 2½-in., will carry at this length. Joining the 2½-in. pipe on the left scale with the *8* on the length scale, and producing through the center or converting scale in direction indicated by the intersecting lines; then joining this point to the 2½-in. pipe on the right-hand scale, we find a maximum allowable load of about 18,000 lb.

To illustrate the necessity for using both halves of this chart, we might have joined the top of the solid line part of the center scale with the 2,300 lb on the load scale, and found that a ½-in. pipe would carry this load as a main member. However, on continuing this through to the left-hand scale, we find that the allowable length of ½-in. pipe supporting this load must not exceed about 2.2 ft.

Thus our pipe frame may be safely used with 4-in. standard-weight pipe cross members and with 2½-in. standard pipe legs for ordinary conditions. If, however, the frame is to be located in such a position that heavy weights, etc., may be bumped against the legs, the next larger pipe size should be chosen.

Stopping Vibration of a Steam Line

. . . . *By* **Bernard Kramer***

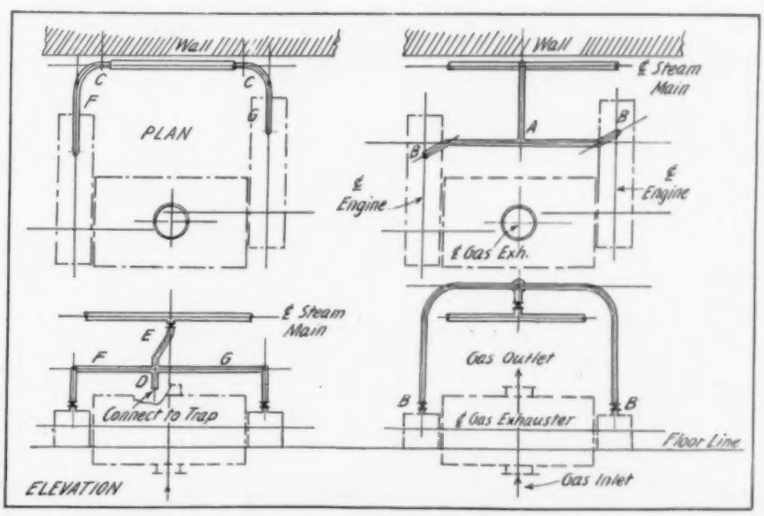
A POSITIVE gas pump (gas exhauster of the rotary type) has its two propellers driven by two reciprocating engines, one at each side of the exhauster. The shaft of one propeller extends to one side and is direct-connected to its engine, while the shaft of the other extends the opposite way and is direct-connected to the second engine. The two propeller shafts are geared together, but the load of each propeller is normally supposed to be carried by its own engine. Therefore the two engines must run in synchronism. From the right-hand view in the sketch, it may be noted that the offtake from the main steam line was located midway between the steam inlets of the two engines. After turning up and over horizontally to point *A* the main offtake branched out into two leads connecting to the engines at points *B*. The pipe leads were duplicates of each other. In this way the steam paths to both engines operating the gas exhauster were as nearly alike as possible.

The steam main was located alongside of the engine room wall about 15 ft above floor level, and was anchored at the wall columns in the vicinity of the exhauster. However, the unsupported distance from the main offtake to the steam inlets on the engines was evidently too great. No trouble occurred in this case, for when vibration of the piping became marked, the man in charge decided not to wait for the accident to happen.

The change was made as shown in the left-hand part of the sketch. The main offtake tee was turned downwards. This procedure is not advisable to follow in ordinary practice, as it may mean wet steam for the engines. In this case, however, a water leg connected to a steam trap was provided at point *D*. This proved to make for even better moisture separation than by turning the offtake upwards. The offset in the main offtake at *E* is to equalize the leads to the two engines. Though not duplicates of each other, connections *F* and *G* each have two 90-deg bends and the same total amount of straight pipe. Each of the two leads was anchored to the wall at points *C*. This arrangement eliminated all visible and audible manifestations of the vibration.

Excessive vibration in pipe lines may not always be predicted from the de-

To the right is shown the steam piping to two engines driving the two propellers of a rotary-type gas exhauster. To reduce vibration of the piping the arrangement was changed as shown at the left, stopping the trouble



* Mechanical Engineer, Pittsburgh, Pa.

sign. In defense of the original layout described, such installations sometimes go by without causing any commotion beyond a slight pulsating or throbbing of the pipe line, which is ordinarily not considered objectionable. The reason for such variation may probably be traced to some slight imperfection in the assembly or setting of the engine, an imperfection not in itself sufficient to affect its operation, but which is magnified in a long pipe perfectly free to vibrate.

The convenient thing about trouble from excessive piping vibration is that its occurrence is readily noticeable and gives ample warning so that corrective measures may be made. Such corrective measures should not be neglected.

Several Piping Tools I've Found Handy

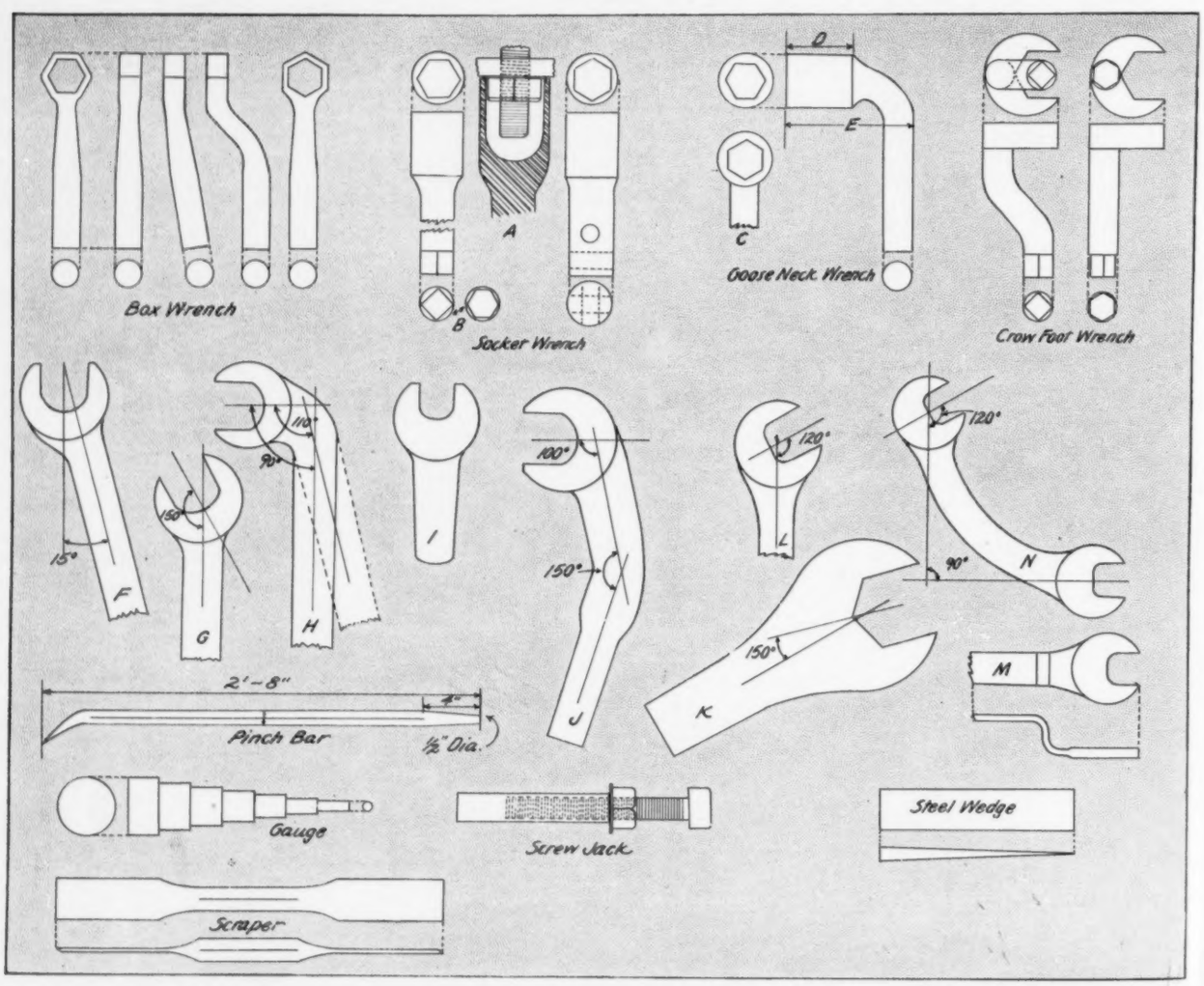
. . . . By W. H. Wilson

GOOD tools are necessary to produce good workmanship in any mechanical undertaking. Pipe work requires tools peculiar to its requirements.

In piping maintenance work close quarters and restricted spaces are the rule. Many of the wrenches shown are of patterns not regularly furnished, but can be procured on order or made by shop tool makers. All of them have been useful in piping maintenance.

The **box wrench** is a good one and has many uses, as it permits a strong grip on the nut, with little chance of the jaws spreading. The head of the wrench should be thin for use where clearance is limited. For this reason it cannot be used

Good piping maintenance requires good tools, and reliable manufacturers can furnish many time- and money-saving types. Here are several wrenches, a valve-stem packing gauge, a scraper, etc., which one maintenance engineer has found especially useful



in some places where an open-end wrench can be used. The box wrench can be made with the straight, inclined, or offset handle. The point of the hexagonal opening may be set in line with the handle, or the flat, or otherwise. The handle of this wrench is round to allow a piece of pipe to slip over it for additional leverage. For pipe work it is better to make the handles of most types of wrenches short and strong; the wrenches can then be used in close quarters and a pipe extension of any convenient length added easily when required.

The **socket wrench** can be made with a square or hexagonal shank to fit the commercial ratchet wrench handle. This combination makes a most convenient wrench for the pipefitter. An important feature of the socket wrench is the length of the socket, dimension *A*. Many of the bolts on pipe work project through the nut (such as packing box gland bolts). It is necessary to make the opening in the socket longer to accommodate the end of the bolt, shown at *A*. Attention should be given to the thickness of the wall of the socket. Certain places on hydraulic pipe work, and the older Van Stone flanged pipe joints of the long hub pattern, have a limited amount of clearance between the outside of the nut and the hub of the flange or pipe, making it necessary to have the wall thickness as thin as possible to allow the socket to fit over the nut. A set of socket wrenches with the openings set in different positions with the square or hexagonal shanks and used in connection with a ratchet handle will allow nuts to be tightened in places where the movement of the wrench handle is limited. The socket wrench can be turned with a bar when made with holes drilled in the handle as shown. The end of the pinch bar can be used for this purpose.

The **goose neck wrench,** or offset socket wrench, is useful on flanged joints in a vertical pipe line. As in the case of the regular socket wrench, the length of the socket *D* should be considered, as well as the location of the opening *C* with reference to the handle. The handle is made short and to fit a pipe extension. The effectiveness of this wrench is governed by the dimension *E*. When this dimension is short the wrench can be used in close quarters, while in some cases it is necessary to increase this length to enable the wrench handle to pass over obstructions.

The **crow foot wrench** is well adapted to tightening bolts in restricted places, especially when the bolts have little clearance with the hubs of flanges and the pipe. This wrench is shown with the offset and the straight handle. The end of the handle may be square or hexagonal to fit the ratchet handle.

The **open end wrench,** universally used, is made in a number of patterns. The wrenches *F*, *G* and *L* are **all-purpose wrenches.** *H* is a pattern that can be used where space is limited. The wrench *J* can be used to advantage when the bolts are close to the floor or near a wall. Wrenches *I* and *K* are heavy wrenches for large nuts used on hydraulic pipe work; they are extra strong and short for use in limited space. A sledge may be used on the handle for final tightening. The wrench *N* is suitable for tightening expansion-joint packing-box gland bolts where the bolts are obstructed by guides, tie rods and nearby pipe lines. Any of these wrenches may be made in the offset pattern, *M*.

The pinch bar shown should be made with a blunt point on the end and a taper suitable for inserting in the bolt holes of a flange in order to bring them in proper alignment when connecting flanged joints. The dimensions shown are suitable for 6 to 12-in. pipe sizes.

The gauge for cutting coil packing for valve stems is worthy of consideration. It is a piece of hard wood, turned on a lathe, making each section of a different diameter, corresponding to the size of the valve stems in use. It is not simple, convenient or easy to take a piece of greasy packing and pass it around the hot stem of a steam valve or around the stem of any valve when there is little room between the yoke and the gland bolts. With the gauge, the diameter of the valve stem is measured with small calipers and the section of the gauge corresponding to this diameter is noted. The packing may then be wound around the proper section of the gauge and the rings of packing cut to the required length.

The scraper is used in cleaning the faces of the flanged joint before assembling the new gasket. It should be made of steel that will hold an edge. The side edges of the blades should be ground true, as these can be used for cleaning as well as the beveled ends. For general requirements this scraper can be made of ⅞-in. tool steel, blades 1½-in. wide, with a length of 14 to 18 in.

The screw jack is useful when it is necessary to separate flanges, relieve strains or bring flanges into proper alignment. It is made by threading a bolt the entire length, procuring a piece of pipe that will slip over the bolt and using a washer and nut. Any reasonable required length can be made up in this manner.

The steel wedge is used for separating valve bonnets, flanges, steam trap covers, etc. A number of these wedges, of different sizes, should be among the pipefitters' tools. A convenient size is length, 7 in., width, 1¼ in., maximum thickness, ½ in.

Conventions and Expositions

American Society of Mechanical Engineers: Annual meeting, Dec. 5-9, New York City. Secretary, Calvin W. Rice, 33 W. 39th St., New York City.

National Power Show: At Grand Central Palace, Dec. 5-10, New York City. Managers, Charles F. Roth and Fred W. Payne, International Exposition Co., Grand Central Palace, New York City.

American Society of Refrigerating Engineers: Annual meeting, Hotel New Yorker, New York City, Dec. 7-9. Secretary, David L. Fiske, 37 W. 39th St., New York City.

National Warm Air Heating Association: Meeting, Dec. 7-8, Urbana-Lincoln Hotel, Urbana, Ill. Managing Director, A. W. Williams, 3440 A. I. U. Bldg., Columbus, Ohio.

American Society of Heating and Ventilating Engineers: Annual meeting, Jan. 23-25, Hotel Gibson, Cincinnati, Ohio. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

EDITORIAL

Most engineers in charge of a plant or building heating, piping or air-conditioning system know that by certain maintenance or replacement operations economies well worth the necessary investment could be made. Many realize that improved equipment now available could be installed in place of obsolete equipment to cut operating cost, improve the service given, or both. But whether or not to recommend or go ahead with modernization, rehabilitation, improvement (call it what you will) is the question.

What is needed is specific information on the results accomplished by plants and buildings that have found exactly what modernization of heating, piping, and air-conditioning services means. In addition to this, so many new and improved types of equipment have become available in recent months that no one man is familiar with all of them and what they can do. What is this equipment which offers possibilities along these lines?

For many months these pages have carried information on what this operating engineer, what that designing engineer, and what another maintenance engineer did to save on the cost of heating, of piping, or of air conditioning or to improve the service given by such systems. Articles have described the engineering features of the job, the reasons for its undertaking, the specific advantages resulting. Recently, check-lists—one appears in this issue—have put in convenient form guides for discovering sources of waste and suggested their correction. Developments in heating, piping and air-conditioning equipment and the purposes to which this equipment can be put have been covered.

Next month's HEATING, PIPING AND AIR CONDITIONING—The Modernization Number—will tell what modernization means, both to the individual plant or building and to business in general, what the opportunities are in a general modernization program or a modernization job, what actually has been accomplished in plants and buildings that have modernized; it will summarize the new and improved equipment available for modernization.

To the engineer thinking about cutting operating cost of the heating, piping, or air-conditioning services in his plant or building, the January number will present a wealth of specific data. It will give the information needed to look at the specific question from a viewpoint as broad as these services are important.

Heating·Piping
and Air Conditioning

American Society of Heating and Ventilating Engineers JOURNAL SECTION

DECEMBER 1932

Material in this Section prepared by Publication Committee: F. D. Mensing, *Chairman;* E. O. Eastwood and F. E. Giesecke
A. V. Hutchinson, Manager of Publications

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Flow of Condensate and Air in Steam-Heating Returns

By **F. C. Houghten*** (*MEMBER*) **and Carl Gutberlet†** (*NON-MEMBER*), **Pittsburgh, Pa.**

This paper is the result of research conducted at the Research Laboratory of the American Society of Heating and Ventilating Engineers in cooperation with the Heating and Ventilating Department of Carnegie Institute of Technology.

DATA covering capacities of 1-in. dry and wet return mains and return risers were recently published[1, 2] by the A. S. H. V. E. Research Laboratory. It was thought that the results of these studies would serve as a basis for revising the return capacities of pipe size tables in the A. S. H. V. E. GUIDE. However, in endeavoring to apply the data obtained to the development of capacities for returns larger than 1 in., it was found that there were still too many unknown factors, and as a result the Technical Advisory Committee on Pipe and Tubing Carrying Low Pressure Steam and Hot Water, of which S. R. Lewis is chairman, requested additional information on 1½-in. and 2-in. returns. The Laboratory was also requested to supply data on the rates of condensation and air return during the heating-up period from actual installations.

Test Equipment and Operation

In general, the set-up for the study and the methods of conducting the tests were similar to those used in the earlier studies on 1-in. pipe. Since an excessive amount of steam condensing surface would have been necessary for the tests on the larger pipe, it was decided to simulate air and water flowing from radiators through the return risers and mains by mixing measured quantities of air and hot water, and admitting this mixture to the top of the return riser. This obviated the necessity of supplying a great amount of heating surface with an accompanying large steam cost, and worked well in operation, giving satisfactory control of all of the factors entering into the problem.

A diagrammatic sketch of the equipment used in the test set-up is shown in Fig. 1. Two different systems having the dimensions given in Table 1 were studied. Water at steam temperature was delivered at a constant rate from the 150-gal water supply tank through the water orifice flow meter and the horizontal pipe *AB* to the top of the return riser *BC*. At *A*, air was added to the horizontal pipe from the compressed air tank. The rate of supplying the air was controlled by the air orifice flow meter, but the volume added was actually measured at its existing temperature and pressure by the wet gas

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[1, 2] See Bibliography at end of paper.

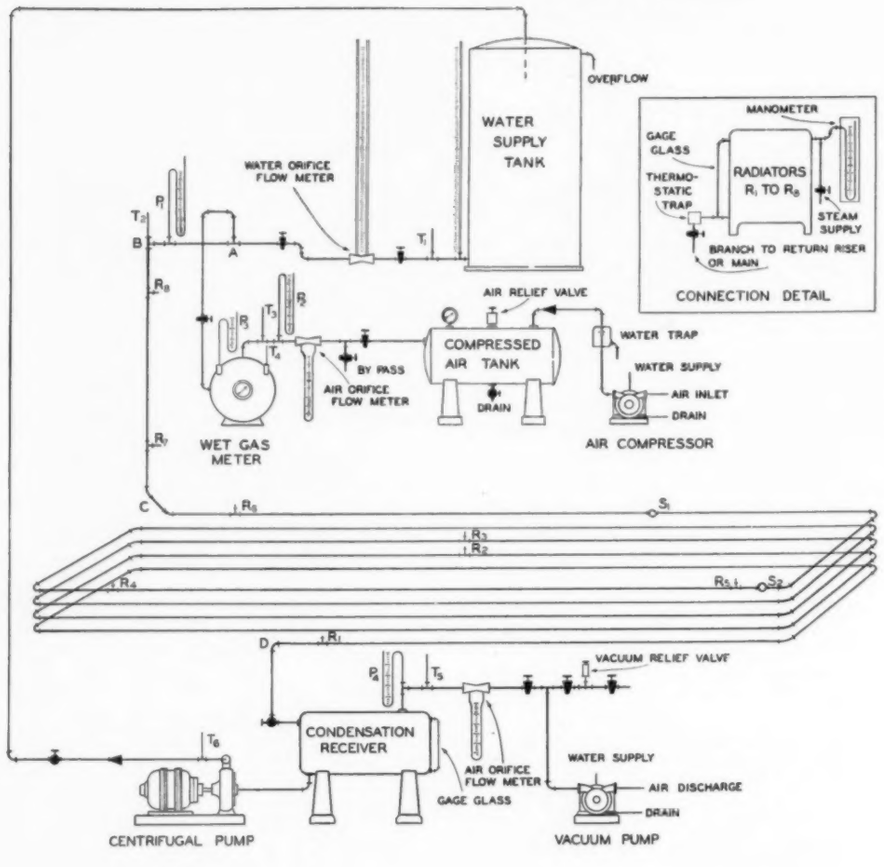

Fig. 1 — Laboratory set-up for studying capacities of returns

meter. The 10-ft, 2-in. horizontal pipe *AB* was considered of sufficient length to allow the water and air to adjust themselves, so that by the time they reached *B* they would be in a condition as though they had come from heating units in a steam heating system. The air and water mixture, after passing down the return riser *BC* and through the coils of the return main *CD*, was delivered to the condensation receiver, from which, under gravity operation, the air was allowed to escape to the atmosphere, or from which it was removed by the vacuum pump. Water from the condensation receiver was returned by the centrifugal pump to the water supply tank, where it was reheated by passing steam directly into it.

Two 45-deg elbows connected the return riser into the return main, which in each case consisted of about 319 linear feet of the pipe tested. The return main was fitted into four complete loops when the 1½-in. pipe was used, and five complete loops when the 2-in. pipe was used. It was accurately laid out with a pitch of 1 in. in 16 ft. The ends of the loops were 18 in. long.

Along the return riser and main, eight radiators, each of 12 sq ft (equivalent) capacity, were connected at points R_1 to R_8 as shown in the sketch. These radiators served to indicate when the return at any particular point was overloaded. With the steam supply valve to the radiator closed, and the gate valve between the thermostatic trap and the return open, the manometer on the radiator indicated the pressure in the return.

In using a radiator to determine when the return was overloaded, the valve between the radiator and the return was left open, while the steam supply valve was opened and adjusted to maintain a pressure in the return ¾ oz greater than that observed before the steam was admitted. If any radiator required more than six minutes to heat up, the return at this point was considered to be overloaded, basing this time on the assumption that a fairly large radiator, of about 60 sq ft (equivalent) capacity, should heat up in thirty minutes for satisfactory operation. Actually, it was found that if the

Table 1—Dimensions of the Pipe Systems Studied

	Size of Pipe		Distance from Lower End of Main in Feet									
	Riser	Main	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	Bottom of Riser	Top of Riser
System 1	1½	1½	1.75	96.30	178.75	242.90	279.20	316.20	321.00	329.20	319.18	330.78
System 2	1½	2	2.54	105.35	173.41	260.98	289.98	315.47	320.03	328.38	318.45	329.96

pressure in the return was 1 oz or less before admitting steam, the radiator heated up satisfactorily within the accepted time, while if the pressure in the return was greater, the radiator seldom heated up in this time.

To observe the effect of fittings on the pressure drop, the radiators were connected to the return mains so that pressure drops could be obtained through the entire length of the return, through one straight length of pipe, or through one complete loop. It was found, however, that pressure drops could not be determined accurately enough through such short sections to furnish satisfactory data on this point. In the system, other pressures were observed by manometers at points P_1 to P_4. Temperatures were observed by thermometers at points T_1 to T_5. Through glass observation sights located in tees at S_1 and S_2, the degree of turbulence of flowing water could be observed in either a straight run of pipe or immediately after the water had flowed through an elbow.

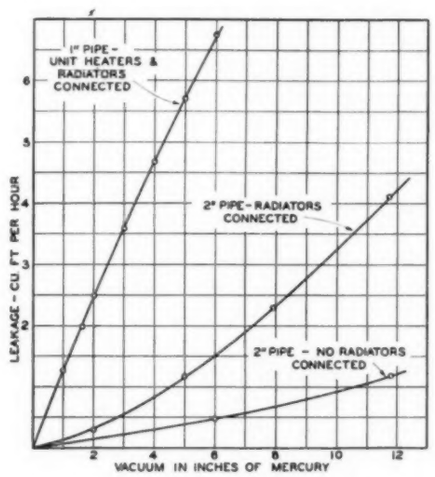
1" PIPE - UNIT HEATERS & RADIATORS CONNECTED
2" PIPE - RADIATORS CONNECTED
2" PIPE - NO RADIATORS CONNECTED
LEAKAGE - CU FT PER HOUR
VACUUM IN INCHES OF MERCURY

Fig. 2 (above)—Leakage of air into pipe systems

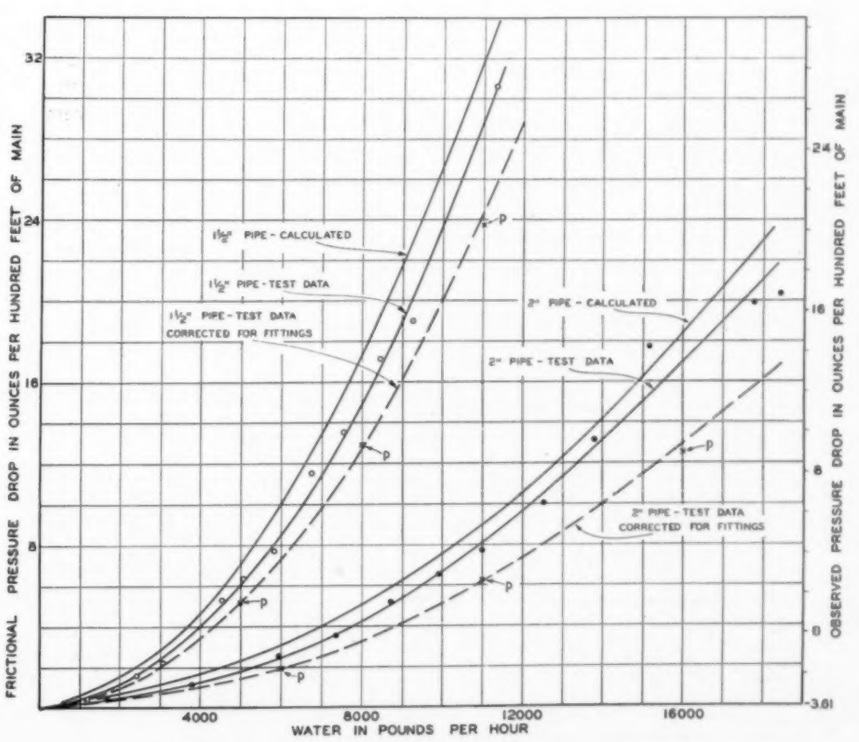
1½" PIPE - CALCULATED
1½" PIPE - TEST DATA
1½" PIPE - TEST DATA CORRECTED FOR FITTINGS
2" PIPE - CALCULATED
2" PIPE - TEST DATA
2" PIPE - TEST DATA CORRECTED FOR FITTINGS
FRICTIONAL PRESSURE DROP IN OUNCES PER HUNDRED FEET OF MAIN
OBSERVED PRESSURE DROP IN OUNCES PER HUNDRED FEET OF MAIN
WATER IN POUNDS PER HOUR

Fig. 3—Flow of water through wet return mains

Test Results

With the set-up as described, great freedom was possible in obtaining data. Any reasonable amount of air and water in any ratio could be supplied at the top of the system, while the bottom could be operated under atmospheric conditions or a wide range of vacuum. By simple mechanical changes of the equipment, it was possible to measure the air leakage into the system under varying degrees of vacuum, to measure the characteristics of hydraulic flow when the main was operating full of water as in a wet return, and to study the flow characteristics of air.

Air Leakage Into the System

Before any runs were made on the system, it was tested for tightness by maintaining definite and constant vacuums and measuring the volume of air exhausted in holding these vacuums. These air volumes were determined with the pipe capped at the top of the riser, first with the eight test radiators connected, and second with them disconnected and their return openings plugged. The leakage of air into the system for the 2-in. main, both with and without radiators and fittings, is given in Fig. 2, where the curves show leakage against vacuum maintained for the two conditions, and also the leakage found in the earlier study[1] on a similar set-up with 1-in. pipe. Contrary to expectations, there is considerably more leakage in the case of the 1-in. pipe than with the 2-in., but this may be explained by the greater number of fittings used in the 1-in. set-up, where all water carried was actual condensation from unit heaters. It should be emphasized that the air leakage tests were made under conditions which would give a larger value than would

[1] See Bibliography.

result in actual systems operating under natural conditions. The pipe was cold and the vacuum indicated was applied to the entire length of the system instead of at the pump with a gradually diminishing vacuum from this point to the most remote radiator. Under a vacuum of 12-in. of mercury, the 2-in. pipe system leaked 4.2 cu ft per hour when the radiators were connected, and 1.2 cu ft per hour when they were not connected. It was found in the tests on the dry return main that the 2-in. pipe operating under a pressure drop of 1 oz per 100-ft length of run and carrying 0.1 cu ft of air per pound of water, or a rate of air delivery equivalent to an average heating-up period, would carry 189 cu ft of air per hour. Hence, the significance of the quantity of air

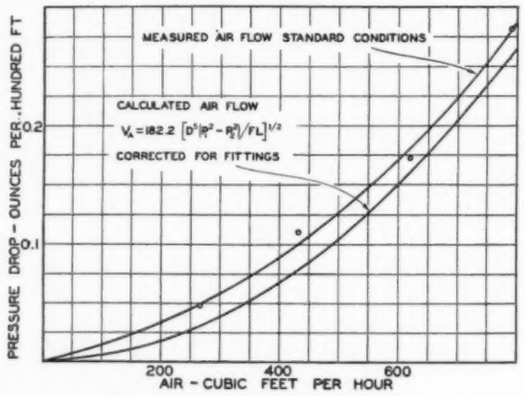

Fig. 4—Flow of air through the 2-in. main

found leaking into the system on its capacity is small. The leakage definitely shows, however, that workmanship and the number of fittings are exceedingly important in the erection of piping where high vacuums are to be maintained.

Wet Return Mains

By excluding air, filling the entire pipe system with water, and controlling the flow by the valve between the main and the condensation receiver, the flow pressure drop relation for the main acting as a wet return was determined, see results for the 1½-in. and 2-in. mains, Fig. 3. Pressure drop curves are shown for the test data using the actual length of pipe including fittings, for the values from these curves corrected for fittings, and for the relations as calculated by the following generally accepted hydraulic formula (including a correction for fittings):

$$W = 3600\,DAC\,\sqrt{RS} \qquad (1)$$

where

W = weight of water in pounds per hour
D = density of water in pounds per cubic foot
C = a constant, depending upon the velocity of flow and smoothness of pipe
R = mean hydraulic radius
S = pressure drop in feet of water column per linear foot of pipe

In using Formula 1, the choice of values for C is important. The calculated curve was drawn by using C equal to 79.8, 81.2, and 82.2 for velocities corresponding to 4,000, 8,000 and 11,000 lb of water per hour for the 1½-in. pipe, and C equal to 82.5, 86.0 and 88.8 for velocities corresponding to 6,000, 12,000 and 18,000 lb of water per hour for the 2-in. pipe, as given by Marks Engineers Handbook.[3] It will be observed that the calculated curve gives considerably lower rates of water flow for the same pressure drop than found by test when both are based upon corrected lengths of pipe. This discrepancy may result from error in the accepted correction for length of pipe for fittings, or it may more likely result from incorrect values of C. The values of C used in the formula were determined many years ago, and may apply for pipe with a considerably rougher internal surface than that found on the market at the present time. It is well known that improvements in the manufacture of pipe have resulted in smoother surfaces. The pipe used in the set-up was the average run of steel pipe found on the market.

If the discrepancies between the calculated and actual flow curves, both corrected for fittings, result from erroneous values of C, then it is of interest to see how much the constant C must be changed in order to make the formula approximate more closely the actual flow in modern pipe. The points P for both sizes of pipe were calculated from the formula but with the accepted values of C from Marks changed by the factor 1.245. It will be observed that these points fit the test data corrected for fittings very well for rates of flow up to about 10,000 lb of water per hour for the 1½-in. pipe and up to 14,000 lb of water per hour for the 2-in. pipe. Above these rates of flow, the formula with the corrected C appears to give rates of flow slightly greater, which may result from errors in experimental data above these rates of flow where few data were taken.

[3] See Bibliography.

Table 2—Typical Test Data

Test No.	Pipe Size, In.	Barometric Pressure	Size H_2O Orifice In.	Size Air Orifice In.	Diff. Press. H_2O Orifice In. H_2O	Rate H_2O Lb Per Hr	Diff Press. Air Orifice In. H_2O	Air Rate Cu Ft Air Per Hr.	Temperature—Deg Fahr					Gage Pressures—In. Hg									Press. Drop Oz Per 100 Ft
									Supply H_2O T_1	Top of Riser T_2	Return H_2O T_6	Air Orifice T_3	Air Meter T_4	Air Orifice P_2	Air Meter P_3	Horizontal Main						Riser		
																R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	
31	1½	28.97	0.50	0.25	11.7	1570	3.2	100.98	207.5	198	174	95.00	95.50	+.30	+.27	−1.55	− .90	− .62	−.22	0.0	+.35	+.28	+.23	4.24
52	1½	29.21	0.50	0.25	11.7	1570	28.0	297.00	207.0	194	169	86.00	86.00	+.38	+.35	−3.00	−2.20	−1.30	−.40	−.30	+.15	+.15	+.20	8.16
70	2	28.99	0.25	0.25	18.00	800	30.0	303.6	207.0	178	146	89.25	85.50	+.20	+.16	− .02	+ .02	+ .03	+.06	+.06	+.07	+.09	+.10	0.21
101	2	29.20	0.75	0.25	17.75	4000	7.0	143.6	208.0	203	189	88.25	88.25	+.90	+.85	−4.00	−2.80	−1.70	−.50	−.15	+.25	+.40	0.0	10.83

The pressure drops due to the frictional resistance to flow are given by the scale on the left hand side of the chart. Actual pressures, measured at points R_1 to R_8 by manometers with one leg open to the atmosphere, were used in calculating the apparent pressure drops which are shown by the scale at the right of the chart. This scale applied only to the curves from test data. For the condition of no flow the observed pressure drop is the hydrostatic head, which based on a 100-ft length of the main, pitched 1 in. in 16 ft, is 3.61 oz. For conditions of flow the pressure drop due to the frictional resistance in the pipe is the observed pressure drop plus the hydrostatic head of 3.61 oz per 100 ft. It will be noted that with no observed pressure drop as indicated by the scale on the right there was considerable flow through both sizes of pipe. This represents a condition where the frictional resistance to flow just equals the hydrostatic head resulting from the pitch of the pipe.

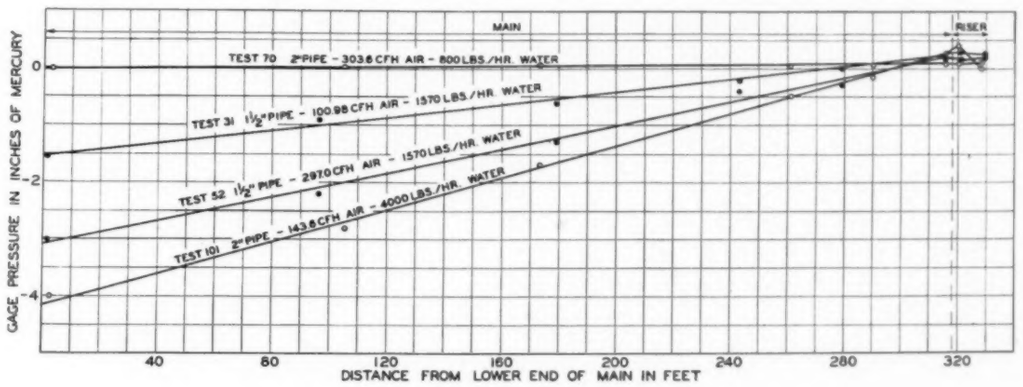

Fig. 5 — Pressure drop for flow of water and air through pipe

Flow of Air in Return Mains

A few tests were made with only air flowing through the returns. The results are plotted in Fig. 4. A curve is also plotted based upon the following formula and constants given by Marks[4]:

$$V_a = 182.2\,[d^5\,(p_1^2 - p_2^2)\,/\,fL]^{1/2} \qquad (2)$$

where

V_a = cubic feet of air per hour at 60 F and 29.92 in. of mercury

d = internal diameter of pipe in inches

p_1 and p_2 = initial and final pressures in pounds per square inch

L = length of pipe in feet

f = coefficient of friction $= 0.0028\left(1 + \frac{3.6}{d}\right)$

Dry Return Mains

Tests were run on the system under a wide range of practical conditions of operation to enable the characteristics of dry returns to be studied. The rates at which air and water were allowed to flow through the system were predetermined and held constant by the valves between *A*, Fig. 1, and the compressed air tank and the water flow orifice, respectively. For each test using vacuum, the pressure in the condensation receiver was adjusted for the predetermined water load, so that the pressure drop through the system would be just sufficient to allow radiator R_6, farthest from the vacuum pump, to be heated up in about six minutes. Tests with gravity operation were made under similar conditions, excepting that the air entering the receiver from the return was allowed to escape to the atmosphere.

After conditions of test had been established and all factors maintained in equilibrium for a sufficient length of time to obtain uniform performance throughout the entire system, all pressures, temperatures, and gage readings were observed and the rate of air supply was determined by the wet gas meter over a five minute period. Typical data obtained by test are shown in Table 2.

All air volumes were corrected to saturated air at a pressure of 29.92 in. of mercury and a temperature of 85 F. This temperature was used rather than 60 F because it was found to be approximately a mean of the temperatures under which the wet gas meter operated in the entire series of tests. Unless otherwise stated, all air volumes are assumed to be measured under these conditions, though they are not the conditions under which the air flowed through the pipe, in which it was necessarily saturated at the water temperature. In Fig. 5, the pressures observed in the mains for the tests listed in Table 2 are plotted against actual length of pipe without correction for fittings. It was found that these curves were best drawn as straight lines from which the pressure drop for any test was determined in ounces per 100-ft length of pipe.

By plotting the volume of air handled in tests run with varying air rates at certain definite condensation loads against pressure drops through the main, the curves shown in Figs. 6 and 7 were drawn for the 1½-in. and the 2-in. dry return mains, respectively. The actual points on which the curves were based are shown. These curves are similar to those reported in the earlier paper on 1-in. pipe and show a tendency to reverse their direction for loads between 1,140 and 1,355 lb of condensate per hour for the 1½-in. pipe, and for loads between 1,750 and 2,000 lb for the 2-in. pipe. In order to study this change in characteristic of flow, the glass observation sights S_1 and S_2, Fig. 1, were installed, and it was found that for approximately the same load limitations the movement of water changed from comparatively quiet flow, with small waves in the lower part of the pipe, to turbulent flow, with water waves reach-

[4] See Bibliography.

ing the top of the pipe and with slugs of water separated by air pockets pulsing through the pipe. This change in condition of flow no doubt accounts for the change in curvature.

In order to put the data from Figs. 6 and 7 in adequate form for building up tables of pipe sizes for use in design under any accepted condition of operation, the ratio of air in cubic feet per hour to water handled in pounds per hour was plotted against the water load and its accompanying pressure drop in Figs. 8 and 9, which give a series of curves for ratios ranging from 0.005 to 0.30 cu ft of air per hour per pound of water per hour.

The capacity of return piping must be based upon the quantity of air and water to be handled when the two combine in some ratio to offer the greatest load on the system. This will obviously come at some time during the heating-up period, and will of necessity bear some relation to it. Hence, to accurately determine the proper size of a dry return main, it is necessary to know not only the heating-up period and load, but also either the maximum rate of air flow or the ratio of air to condensate. Therefore, Fig. 9 in the earlier report and Figs. 8 and 9 of this report may be used directly for design data, or design data may be prepared from them on any assumed ratio of air to condensate handled during the heating-up period. In order to be able to extrapolate the results of the study on these three sizes of pipe to larger sizes, curves are given in Fig. 10 for a 1-oz pressure drop with air-water ratios of 0.01 to 0.3, and also for an air-water ratio of 0.01 with pressure drops of 3, 5 and 10-oz. Similar series of curves were drawn for pressure drops varying from ½ to 10 oz,

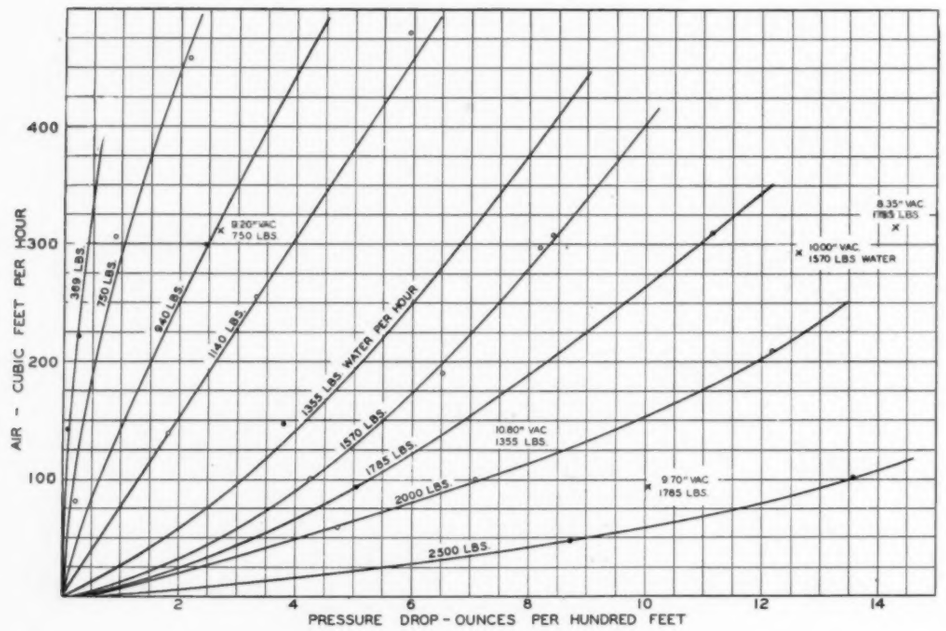

Fig. 6 — Relation of pressure drop to flow of air and water through 1½-in. pipe

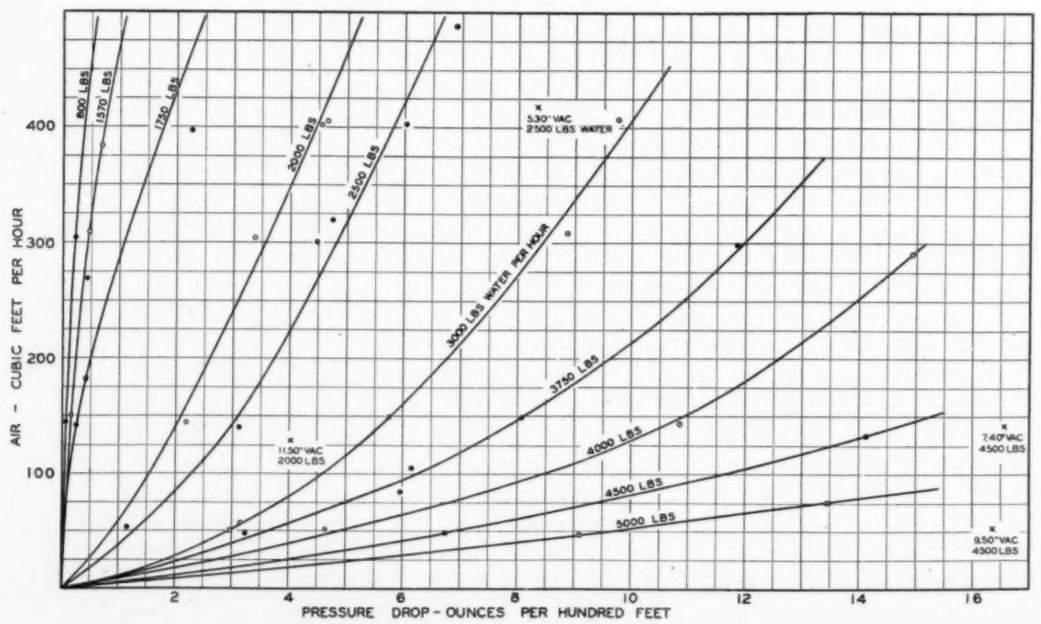

Fig. 7 — Relation of pressure drop to flow of air and water through 2-in. pipe

and equations applying to each band of such curves for each particular pressure drop were analyzed by plotting their component parts on semi-logarithmic and logarithmic paper, with the resultant development of the empirical formula,

$$L = (2.18\,P^{0.04820} - P^{0.36808}\log R) \times (157.08\,d^2 + 80) - 500 \quad (3)$$

where

L = condensation load in pounds per hour
P = pressure drop in ounces per 100 feet
R = ratio—cubic feet of air per pound of condensate
d = actual internal diameter of pipe in inches

Values given in Table 3 are based upon Formula 3, which fits the actual test data to within ± 7 per cent, and are selected for a range of conditions on which any logical set of pipe size tables might be based. Pipe size tables for design purposes may be based upon curves similar to Fig. 10, Table 3, or upon Formula 3, after such operating characteristics as the length of the heating-up period, the maximum air and condensate return load during this

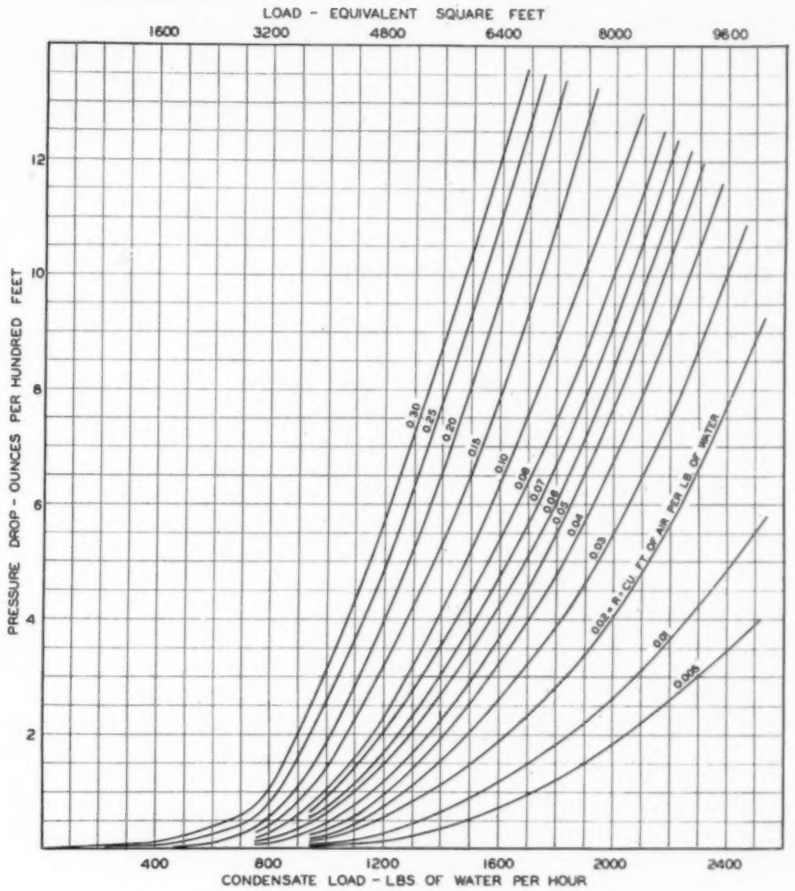

Fig. 8 (above)—Relation between pressure drop and condensate load for various air-water ratios—1½-in. pipe

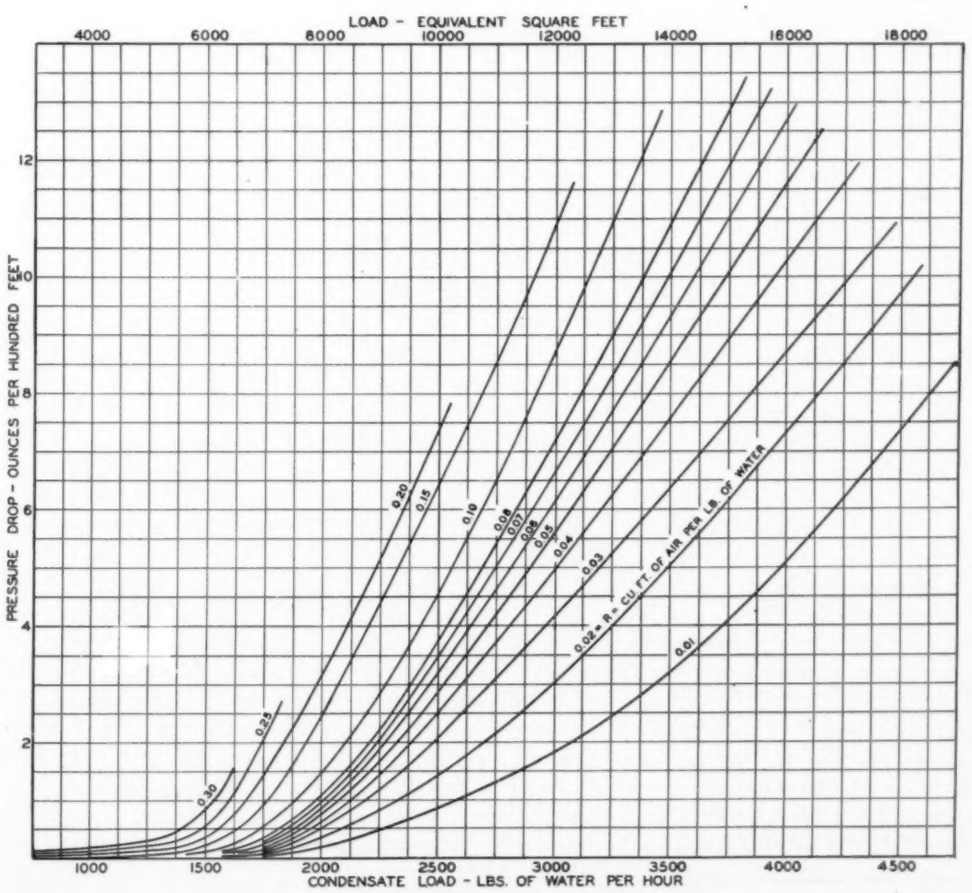

Fig. 9—Relation between pressure drop and condensate load for various air-water ratios—2-in. pipe

Table 3—Relation of Pressure Drop and Air-Water Ratio to Condensate Load for Dry Return Mains

Nominal Size of Pipe—Inches		¾	1	1¼	1½	2	2½	3	3½	4
Pressure Drop Oz Per 100 Ft *P*	Cu Ft Air Per Pound Water *R*	Condensate Load Pounds Per Hour								
0.5	.01	183	425	886	1282	2247	3296	5201	7025	9106
1		280	557	1084	1537	2639	3837	6014	8099	10477
2		402	722	1333	1856	3131	4517	7036	9447	12198
3		488	839	1507	2080	3477	4995	7753	10394	13406
4		557	931	1646	2259	3752	5375	8325	11148	14368
5		615	1010	1764	2410	3985	5697	8809	11787	15184
10		825	1296	2192	2961	4835	6871	10572	14114	18154
0.5	.02	139	366	798	1169	2072	3054	4838	6546	8494
1		224	481	970	1390	2413	3525	5546	7480	9686
2		330	624	1185	1667	2840	4114	6431	8648	11577
3		404	725	1336	1860	3138	4526	7050	9466	12221
4		463	805	1456	2014	3376	4855	7543	10116	13052
5		513	872	1557	2145	3577	5132	7960	10667	13754
10		695	1118	1926	2619	4307	6142	9477	12668	16309
0.5	.03	114	331	746	1102	1970	2912	4625	6265	8135
1		191	436	903	1304	2281	3342	5271	7118	9224
2		287	567	1099	1556	2669	3878	6077	8180	10580
3		355	658	1236	1732	2940	4253	6639	8923	11528
4		408	730	1345	1871	3155	4550	7086	9513	12282
5		454	792	1437	1990	3337	4802	7464	10012	12918
10		618	1014	1770	2418	3999	5715	8836	11823	15230
0.5	.04	96	307	710	1055	1897	2812	4474	6066	7881
1		168	405	856	1243	2187	3212	5077	6860	8896
2		257	526	1038	1477	2548	3711	5825	7849	10157
3		320	611	1165	1640	2799	4059	6347	8538	11037
4		369	678	1266	1770	2999	4334	6762	9085	11735
5		411	735	1350	1879	3168	4567	7112	9547	12325
10		563	941	1660	2276	3780	5413	8382	11223	14464
0.5	.05	82	288	681	1018	1840	2734	4357	5911	7684
1		150	380	819	1196	2114	3112	4925	6661	8641
2		234	494	991	1416	2454	3581	5630	7591	9829
3		293	574	1110	1570	2790	3908	6121	8239	10655
4		339	637	1205	1691	2878	4167	6510	8753	11311
5		378	690	1285	1794	3036	4386	6839	9186	11865
10		521	883	1574	2166	3710	5178	8029	10758	13870
0.5	.06	70	272	658	988	1794	2670	4262	5785	7523
1		135	360	789	1157	2055	3030	4802	6498	8433
2		215	469	952	1366	2377	3475	5471	7381	9560
3		271	544	1065	1512	2601	3785	5936	7995	10344
4		315	604	1155	1627	2779	4030	6305	8481	10965
5		352	654	1230	1724	2929	4237	6615	8892	11489
10		487	837	1504	2076	3471	4986	7741	10377	13385
0.5	.07	60	259	638	963	1755	2611	4180	5678	7386
1		122	343	764	1125	2005	2960	4698	6361	8257
2		199	447	919	1324	2312	3385	5336	7203	9333
3		252	519	1027	1463	2526	3681	5780	7789	10080
4		294	576	1112	1573	2695	3914	6131	8252	10672
5		329	624	1184	1665	2838	4111	6427	8643	11171
10		458	797	1445	2000	3354	4824	7340	10056	12975

period, the allowable pressure drop, and a possible factor of safety are agreed upon. To help establish these operating characteristics, the A. S. H. V. E. Research Laboratory has made a study of the rates of returning condensate and air in a few actual systems, the results of which will be made the basis of a later report.

Table 3—Continued

Nominal Size of Pipe—Inches		¾	1	1¼	1½	2	2½	3	3½	4
Pressure Drop Oz Per 100 Ft *P*	Cu Ft Air Per Pound Water *R*	Condensate Load Pounds Per Hour								
0.5	.08	52	248	621	941	1722	2570	4111	5586	7269
1		112	328	741	1097	1961	2900	4607	6241	8105
2		185	428	891	1288	2256	3308	5220	7050	9137
3		236	497	994	1421	2461	3590	5644	7610	9852
4		276	551	1076	1526	2622	3814	5980	8053	10418
5		310	597	1145	1614	2759	4003	6263	8427	10895
10		432	763	1393	1934	3252	4684	7287	9778	12619
0.5	.10	38	229	593	905	1665	2492	3994	5431	7071
1		93	304	705	1049	1888	2800	4456	6042	7851
2		161	396	843	1227	2185	3178	5025	6792	8808
3		209	460	939	1350	2252	3440	5418	7311	9471
4		246	510	1015	1447	2501	3647	5729	7721	9994
5		277	553	1078	1529	2627	3821	5990	8067	10435
10		390	706	1308	1824	3082	4449	6934	9312	12026
0.5	.15	12	194	541	838	1563	2350	3781	5151	6713
1		61	259	638	964	1756	2617	4182	5680	7388
2		119	339	757	1116	1991	2942	4671	6325	8212
3		159	393	839	1221	2153	3166	5007	6768	8778
4		191	436	903	1304	2281	3342	5271	7118	9295
5		218	472	958	1374	2388	3490	5494	7412	9599
10		313	602	1152	1624	2773	4023	6294	8467	10946
0.5	.20		170	504	791	1490	2250	3630	4952	6459
1		37	228	591	903	1662	2487	3987	5423	7060
2		89	298	696	1038	1870	2775	4419	5993	7788
3		124	346	768	1130	2013	2972	4715	6383	8286
4		152	384	825	1203	2125	3126	4947	6690	8678
5		175	415	872	1264	2218	3256	5142	6947	9006
10		259	528	1041	1482	2555	3720	5839	7867	10181
0.5	.25		151	476	755	1434	2172	3513	4797	6262
1		19	203	554	856	1589	2387	3836	5223	6806
2		66	266	649	977	1777	2645	4224	5736	7460
3		97	309	713	1059	1904	2821	4489	6085	7905
4		122	343	763	1124	2003	2959	4695	6358	8254
5		143	371	806	1178	2087	3074	4869	6586	8546
10		217	471	956	1371	2385	3485	5487	7402	9587
0.5	.30		135	453	725	1388	2108	3418	4671	6101
1			183	524	817	1530	2305	3713	5060	6598
2		47	240	610	927	1700	2539	4065	5525	7191
3		75	279	668	1002	1815	2698	4304	5841	7594
4		97	309	713	1060	1904	2822	4480	6086	7907
5		116	335	751	1108	1979	2926	4646	6292	8170
10		183	424	886	1281	2246	3294	5199	7022	9101

Gravity Operation

Figs. 6 and 7 include data for both gravity and vacuum pump operation. Where gravity operation was possible and as long as the vacuum applied by the pump was small or just sufficient to overcome friction through the main, the pressure drop relation was the same for both types of operation. Gravity operation was possible only for comparatively small air and condensate loads, the limit in such loads being given in Fig. 11 for the 1½-in. and 2-in. pipe tested in this study and for the 1-in. pipe studied earlier. The limitation curve for a 1¼-in. pipe is drawn by interpolating between the curves for the pipes tested. Air-water ratios as used in analyzing the vacuum pump data are also plotted, and in order to show the relation of air-water ratio to assumed heating-up period as used in the 1-in. pipe study, the location of these heating-up period curves in relation to the ratio curves is indicated.

Return Riser

The return riser was approximately 11.5 ft in length with slightly more than 8 ft between the two radiators R_7 and R_8. This distance was too short to give a measurable pressure drop for accurate analysis, especially when the small pressure difference was masked by the large hydrostatic head of the water in the riser. Hence, it is not possible as a result of the study to give accurate pressure drop, flow data for the riser. Since the capacity of the 1½-in. riser was much larger than that of the 2-in. main, it was left in place while the 2-in. main was being studied. As nearly as could be observed, the capacity of the 1½-in. riser was equal to that of the 2-in. main, both for gravity and vacuum pump operation. For gravity operation, however, more erratic results were found for the riser than for the main. The riser occasionally operated satisfactorily at much greater loads than shown as the limiting capacity for the 2-in. main in Fig. 11. However, these greater capacities could not be depended upon, and as a result, it was concluded that the limiting capacity of the 1½-in. riser for gravity operation is the same as that for the 2-in. main.

High Vacuum

The data presented in the curves in Figs. 6 and 7 and subsequently analyzed cover conditions of operation where the vacuum applied by the pump at the lower end of the main was just sufficient to overcome the frictional resistance to flow throughout the entire length of pipe. A few tests were made with a much higher vacuum which brought the entire return below atmospheric pressure. The results of these tests are shown as points indicated by *X* in Figs. 6 and 7, where the vacuum applied at the condensation receiver, in inches of mercury, and the rate of water carried, in pounds per hour, are listed beside such points. It will be seen that the pressure drop for the same water and air load is greatly increased. This is because of the increase in volume of air flowing under the lowered pressure, and to a lesser extent by the air leaking into the system, both of which took place after the volume of air as plotted was measured by the wet gas meter at atmospheric pressure.

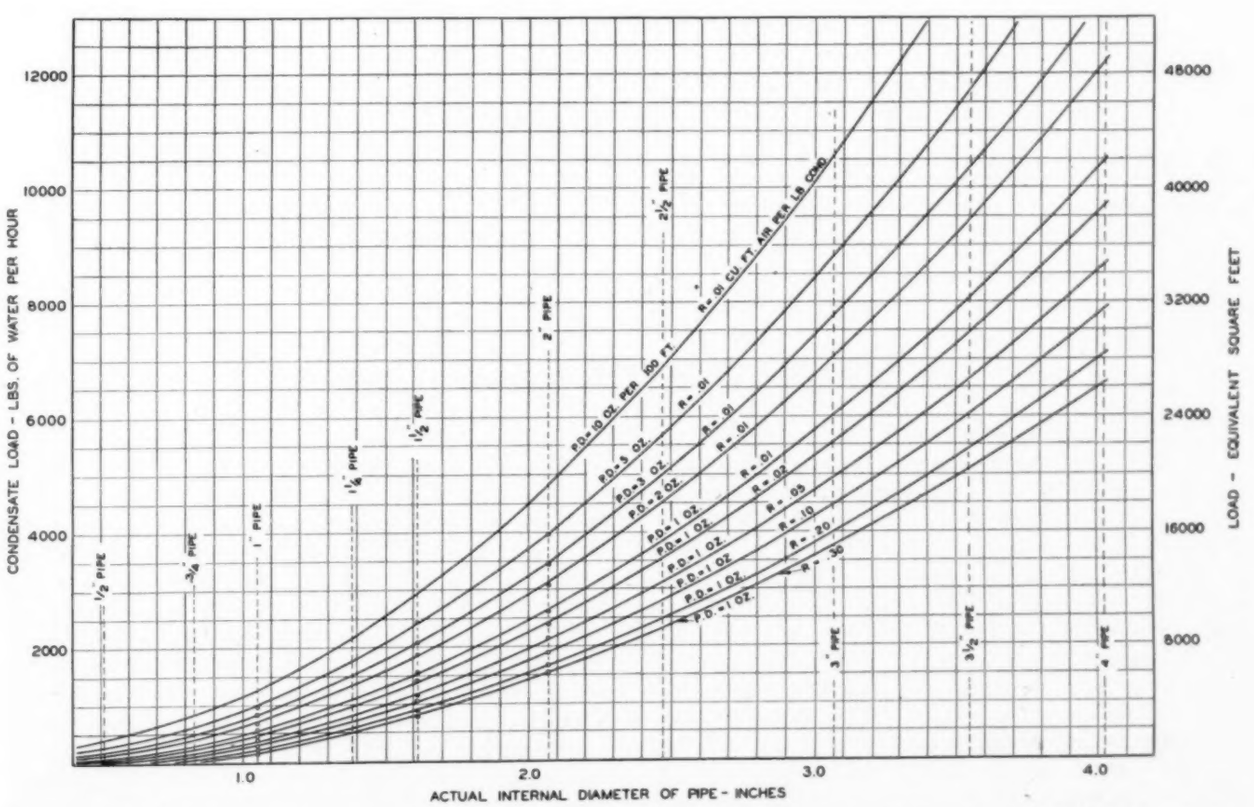

Fig. 10—Relation between condensate load and pipe diameter for various air-water ratios and pressure drops

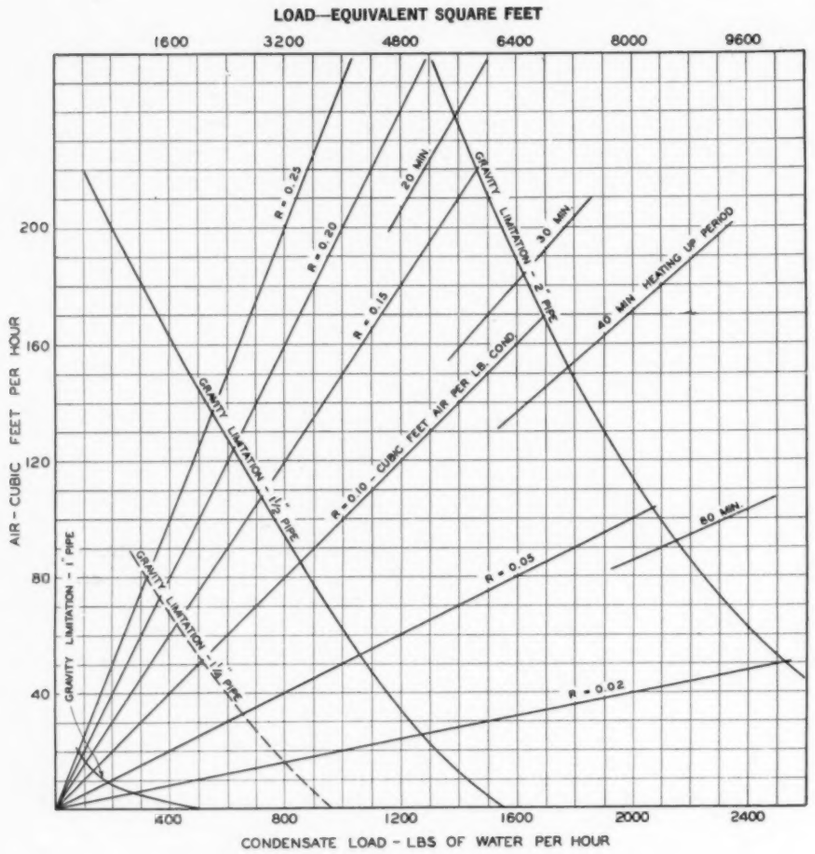

Fig. 11—Limiting capacity of dry return mains for gravity operation

Summary

1. Leakage of air into piping systems under vacuum varies widely with the different set-ups studied, becoming greater as the number of fittings and valves around radiator connections increases. The total leakage, however, even with vacuums applied uniformly throughout the system larger than customarily used in practice, corresponds to comparatively small rates of air flow during normal operation of the system.

2. The pressure drop relation for a return main carrying only water, thus simulating a wet return main, is given for the system studied. Greater rates of water delivery were found for a given pressure drop than would be given by the usual hydraulic formula and accepted constants. Corrected constants giving flows equal to that observed are presented.

3. A much-used formula for flow of air in pipe is shown to give flows which agree closely with those experimentally determined.

4. The pressure-drop-flow relation is given for different ratios of air and water flowing in 1-in., 1½-in., and 2-in. pipe, when operating as a dry return main. The capacities of these three sizes of pipe when plotted against pipe diameter give consistent curves, which are extrapolated with fair accuracy to larger pipe sizes.

5. A formula is developed giving the capacity of pipe for carrying condensate and air based upon the diameter of the pipe, the pressure drop, and the ratio of air to condensate carried. This formula, with curves from which it was developed and related tables, can be used for developing pipe size tables, when the flow characteristics in a heating system under practical conditions are agreed upon.

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2. A. S. H. V. E. research paper entitled, Capacity of Return Risers for Steam and Vapor Heating Systems, by F. C. Houghten and Carl Gutberlet. (*Heating, Piping and Air Conditioning*, October 1930, p. 859.)

3. Marks Handbook, Third Edition, p. 275.

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Temperature Measurement

In engineering work, mercurial thermometers are largely employed to measure the intensity of heat. These depend on the uniform expansion of mercury to indicate changes in temperature. An amount of mercury held in a sealed tube with a bulb at one end, will rise to one definite level when immersed in melting ice, and to another definite level when immersed in boiling water. These two points are marked, and the space between them is divided into a number of equal portions, each of which is called a degree. In the Fahrenheit scale, there are 180 deg thus obtained, while the Centigrade scale has 100 and the Reaumur has 80. Like divisions are marked off on the column above and below these two determined points in order that a greater range of temperature may be read.

Thermocouples may be used to measure any range of temperatures up to 2900 F. When two dissimilar metals are joined at two points and a temperature difference exists between these junctions, an electromotive force will be developed. Its magnitude depends on the composition of the wires and the difference in temperature between the junctions. A potentiometer or sensitive galvanometer of high resistance connected to the thermocouple will give a deflection which is proportional to the temperature difference between the hot and cold junctions. Thermocouples connected in series are called thermopiles.

Thermocouples for the measurement of high temperatures are calibrated with the aid of the known melting points of pure metals.

Air Supply and Its Effect on Performance of Oil Burners and Heating Boilers

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This paper is the result of research conducted at Yale University in cooperation with the A. S. H. V. E. Research Laboratory and the American Oil Burner Association

THIS paper deals with certain performance features related to the manner in which the air for the combustion of oil is supplied. It proposes to show (1) the effect of furnace draft variations on combustion, boiler efficiency, flue temperature and draft loss through the boiler, (2) a probable cause of draft difficulty in practice, (3) limiting factors relative to capacities obtainable, and (4) a possible explanation for inability in some cases to obtain the full rated capacity of a burner. Tests were made on four oil burners. The essential distinctions between these burners are given in Table 1.

Table 1—Essential Features of Four Types of Oil Burners Tested

Burner	Method of Air Supply and Regulation	Oil Regulation
A	Practically entire supply by natural draft-control by furnace draft and slide damper in opening below furnace. Note: In practice slide damper would be adjusted and remain fixed thereafter.	Independent though mixed with small amount of air in pump under pressure to assist atomization.
B	Primary air supplied by fan, entering furnace with the oil in manner intended to achieve good mixing. Secondary air induced by natural draft through opening to furnace located below burner. Primary air control by fan adjustment and furnace draft. Secondary air control by size of opening and furnace draft.	Adjustment in feed line though fuel and primary air adjustments probably interdependent with regard to insuring good mixing.
C	Similar to *B* except in degree—primary air supply relatively larger proportion of the total. Control similar.	Oil feed solely dependent upon rate of primary air feed although controllable initially to some extent at the time of installation.
D	Entire supply from single source under comparatively high pressure. Controlled by suitable fan adjustments and to a slight extent by furnace draft.	Independent regulation.

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Effect of Furnace Draft Variations

The burners were set for a fuel rate averaging about 16½ lb per hour; the furnace draft fixed at 0.02 in. of water and the air regulated to produce a carbon dioxide (CO_2) content of 10 per cent or about 50 per cent of excess air. The efficiencies under these conditions which,

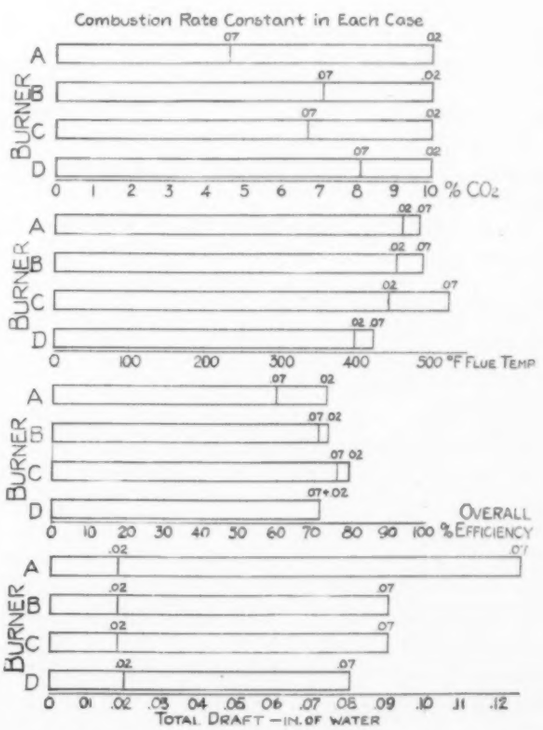

Fig. 1—Effect of change in furnace draft from 0.02 to 0.07 in. of water

although not all the same, were consistent as to type.[4]

The furnace draft was next increased to 0.07 in. of water. Fig. 1 shows that the carbon dioxide (CO_2) and efficiency decreased while the flue temperature and total draft increased, the degree of change being somewhat variable as regards types of burners. This is substantiated by previous tests of a similar character.[4]

If the draft loss through the boiler is calculated (total or smoke-pipe draft—furnace draft) it shows that this value rises rapidly as the carbon dioxide (CO_2) decreases (Fig. 2). It will be noted that seemingly little or no draft loss exists through the boiler at 0.02 in. of furnace draft. This is not strictly true, but the loss in the boiler used was very small. It must also be remembered that whenever a vertical flue passage exists there is a chimney effect present within the boiler itself which

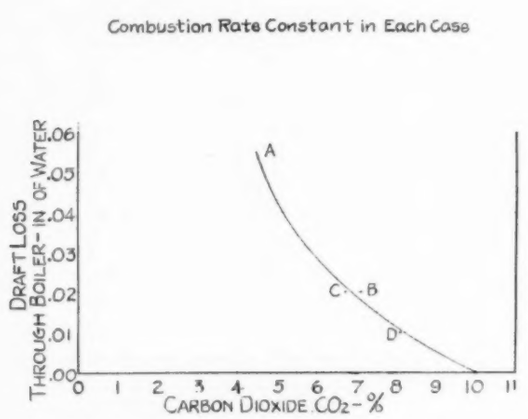

Fig. 2—Relation of draft loss through boiler to per cent CO_2

assists in the movement of the gases. A special gas boiler with a non-mechanical burner is an excellent example where the chimney itself is of no direct help to this boiler because of the hood or back-draft diverter employed. Small, vertical, coal-fired boilers at certain outputs will show a draft reading in the smoke-pipe less than that in the furnace itself. Regardless of this, the smoke-pipe draft is the one that must be produced by the chimney at the boiler outlet and Fig. 2 shows that this requirement does increase rapidly with a decrease in carbon dioxide (CO_2).

Poor Chimney Drafts

One explanation for chimney draft troubles which has not received the attention it deserves may be found from the foregoing statement. It is generally understood that a low percentage of carbon dioxide (CO_2) indicates a large amount of excess air. The actual relation between excess air and per cent carbon dioxide (CO_2) is not so commonly understood (see Fig. 3) and more particularly the principles that relate to the flow of gases.

The latter may be explained by considering the following facts:

1. All gases resulting from combustion, as well as excess air and nitrogen, must flow through the boiler flues, the breeching or smoke-pipe and the chimney.
2. All the flow areas of these passages are fixed in amount.
3. The velocity of the gases through these respective parts, therefore, depends upon the volume of gases to be handled.
4. A certain pressure difference or draft will be required to achieve and maintain these velocities against the frictional resistance of flow.
5. The velocity varies as the square root of the draft head (Velocity = Constant $\sqrt{h}$).

It is evident, therefore, that if twice the volume of gases results in one case as compared to another, due to different air adjustments, the draft required will be four times as great, even though the velocity is only doubled. Whereas this example may represent the difference between a good and a poor installation, the variation in draft requirement is so great that in practice the difference between a *moderately good* and an *only fair* adjustment may be critical if the chimney happens to be *weak*.

The difficulties become cumulative. A poor adjustment calls for a higher oil feed due to reduced efficiencies, thus increasing the volume of flue gases. Furthermore, practically all of the tests to date have shown that an increase in excess air increases the flue gas temperatures. This merely aggravates conditions because the effect is to increase the volume of flue gases beyond that due to the excess air alone. Although this increased temperature may improve chimney draft to some extent, any resulting increment in draft will always be insufficient to produce the increment in velocity which the same event makes necessary.

Furthermore, oil burners, with few exceptions, are set

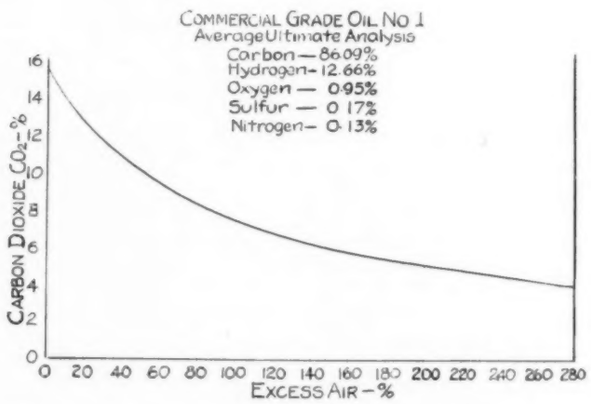

Fig. 3—Relation between per cent CO_2 and per cent excess air

to produce the maximum heating load imposed by the heating system. This means that the chimney is expected at all times to handle comparatively large quantities of gases. This is another reason for not adding the *final straw* which in this case is excess air. It is not to be assumed from the foregoing that a great many chimneys are inadequate for oil burners. There are *border line* chimneys, however, that would prove troublesome for any method of fuel burning and it is with these that care is required. If a draft condition is bad and no other improvement can be made, the excess air should be

[4] For additional data see A. S. H. V. E. research paper entitled, Study of Performance Characteristics of Oil Burners and Low-Pressure Heating Boilers, by L. E. Seeley and E. J. Tavanlar (*Heating, Piping and Air Conditioning*, May, 1931).

reduced if possible—perhaps the rate of oil feed also in extreme cases.

It is evident if oil and air adjustments are to be well made and maintained that control of furnace draft is absolutely vital to burner *A*, important as to *B* and *C* and comparatively unimportant to *D* (Fig. 1).

Effect on Overall Efficiency

The efficiency curves based on intermittent operation give the truest picture of the average efficiencies obtainable in practice. In order to study this feature of the work the curves were plotted by arbitrarily shifting them from their true values to coincide at 75 per cent efficiency and 1,000 ft-*radiation* boiler output, (Fig. 4). This was done solely for the purpose of comparing the curve shapes and the graph should not be used for any other purpose.

It shows quite clearly that the order of preference would be *D*, *C*, *B* and *A* if during operation they all produced exactly the same efficiency and output as shown by Fig. 4. The differences reflect the relative ease with which air can continue to flow into and through the boiler during the *off* period and thus carry away heat previously stored in the boiler and refractories.

When this is coupled with the fact that the curves could all be lowered by an increase of furnace draft an amount equal to the decrease in efficiency shown in Fig. 1, the influence of the method of air admission becomes most striking.

Factors Influencing Capacity Limits of Oil Burners

The following factors may act as limits on the capacity or fuel-burning rate of an oil burner.

General Considerations

1. The heating load must in practice be the determining factor although there is a lack of uniformity in the allowances made to establish the total or gross heat output required. This should be corrected because the basic problem is one of heat loss from building structures—a problem essentially common to all methods of heat generating. This does not imply equal allowances in all cases but a determination by means of common method of approach.

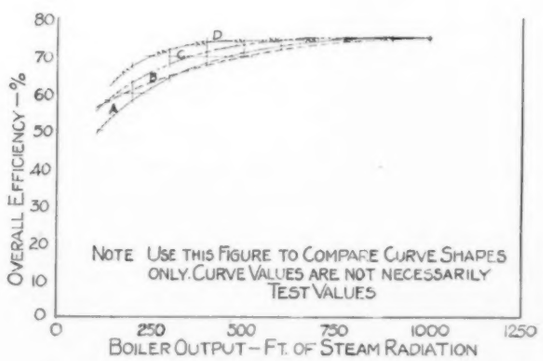

Fig. 4—Intermittent efficiency curves, Series E

0.02 in. of water furnace draft 10 per cent CO_2 during on period 1,000 ft—radiation boiler output

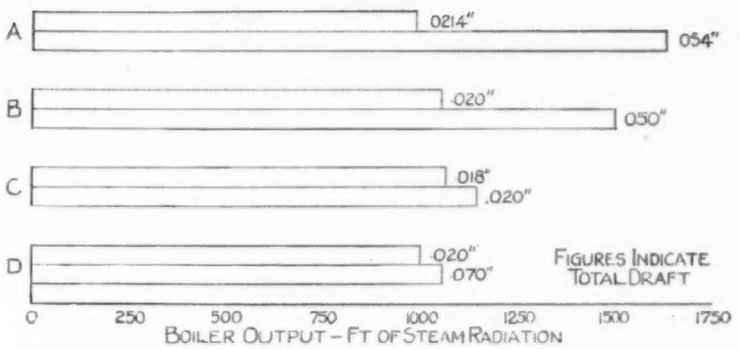

Fig. 5—Relation of total draft to limits of maximum boiler output—10.0 per cent CO_2 in all cases

2. The efficient heat absorbing rate of the boiler or equivalent device should be the most desirable limiting factor. Proper matching of Items 1 and 2 would secure high standards of performance.

Specific Considerations Relating to Oil Burner

3. *The furnace* size and design in conjunction with type of burner and effectiveness of mixing may impose a limit on fuel burning or heat release rate. There is no standard value, however—where 35,000 Btu per cubic foot of net furnace volume per hour seems reasonable for one burner, 80,000 Btu may be reasonable for another. Rates of 180,000 Btu have been obtained with no apparent difficulty. It cannot be concluded that the limits have been satisfactorily explored.

4. The *oil supply* may be limited by pump capacity, size of orifice and fuel pressure, by primary air supply when the method of oil feed is dependent thereon (*i. e.* carburetor principle and oil burner type *B*) or by the total air supply no matter how obtained.

5. The *air supply* may be limited by fan capacity, size of air-supply openings and also by available furnace draft.

Fig. 5 was used as the basis for estimating the probable limiting factors for the burners tested. The values were obtained as follows:

1. The quality of combustion (*i. e.* per cent carbon dioxide) was required always to be at 10 per cent and the flame clean.

2. The air and oil supply and draft was increased, if possible, with the above restriction.

3. The boiler output was measured in every case.

Limits for Burner A—Oil and draft (or air) were not limited—the limit was in the furnace, probably in mixing. If a larger proportion of excess air had been allowed the fuel burning rate might have been increased.

Limits for Burner B—The limit here is problematical—it may have been an atomizing, a primary air or a furnace limitation. It was not secondary air because this could have been increased by raising the draft.

Limits for Burner C—Primary air limit undoubtedly; more primary air would have produced more oil; secondary air could have been considerably increased. Except at maximum capacity no secondary air is needed and only comparatively little if 10 per cent carbon dioxide (CO_2) is to be maintained. Probably better to dispense with secondary air in this case and avoid its disadvantages.

Limits for Burner D—Air capacity limit—increase in draft failed to add much air. It should be pointed out

that a secondary air supply might be devised, making it possible to increase the oil supply and produce the characteristics of Burner *B*.

If it had been the express purpose of this investigation to analyze the precise limits of an intermediate type such as Burner *B*, the oil and air could be increased and if it became necessary to change their relative proportions (*i.e.* increase the excess air) in order to maintain a clean flame, it would clearly indicate a furnace limit of some sort—probably mixing.

Mixing depends upon fuel preparation (*i.e.* degree of atomization, completeness of vaporization and temperature and location of refractory surfaces), velocity of air supplies which includes direction as well as shape and size of furnace. The complications become self-evident. So many solutions actually exist that some burners are found highly independent of and some very dependent upon furnace design in order to secure proper mixing and complete combustion. This, in a measure, explains why the rate of heat release per cubic foot of furnace volume varies so widely in different installations.

Relation of Excess Air to Rated Capacity

Fig. 3 indicates one reason why an oil burner may be considered to be too small when its rated capacity indicates that this should not be the case. If, for example, a burner supplying all its air by means of a fan, is adjusted to 12½ per cent carbon dioxide (CO_2) with a certain furnace draft, the maximum rate of fuel burning will be established when the fan is wide open. If the burner is rated at this value or even somewhat less and then placed in the field where an adjustment of only 4.8 per cent of carbon dioxide (CO_2) is obtained—a possible event—it means that twice as many pounds of air per pound of fuel are being supplied. The result is that only about one-half of the original amount of oil can be burned. If the furnace draft is the same the fan can deliver no more air on the job than in the laboratory. The boiler output will be reduced usually more than half due to lower efficiencies. The burner is considered to be too small when a better adjustment of oil and air (*i.e.* decrease in excess air) might remedy the trouble. The adjustment of oil and air cannot be properly measured except by analyzing the gases by means of an Orsat.

While the foregoing is not the sole cause for such a condition, (*i.e.* the furnace design may be unsatisfactory) it is still true that the actual quality of performance conclusively rests upon those who install the equipment.

Conclusions

1. In a burner which receives its air supply by natural draft exclusively the quality of combustion is very sensitive to draft fluctuations. This is important because of the adverse effect on efficiency. In practice the supply of air could be either too great or insufficient unless carefully adjusted and precisely regulated thereafter. During intermittent operation its stand-by or off-period losses will run higher than other burners.
2. A burner which receives its air supply exclusively from a fan will generally be the least sensitive to draft changes and more satisfactory during intermittent operation. This will differ in degree depending upon the relative resistance which the fan and other parts set up to the flow of air during the off-period.
3. Intermediate types will generally occupy the middle ground between the preceding two. There will never be a sharp line of demarcation and a certain amount of overlapping is to be expected.
4. If a means could be found to stop the flow of air through a boiler during the off-period regardless of type of burner the foregoing differences on intermittent operation would virtually disappear and the average efficiency would be increased.
5. Where unsatisfactory draft conditions are encountered, excess air should be reduced as much as practicable, the furnace draft should be kept reasonably low and provision should be made for automatic draft regulation.
6. If the maximum fuel burning rate proves to be insufficient for the job it may in some cases be raised by reducing the excess air. Furnace alterations to secure better mixing and combustion may also be necessary.
7. The greatest improvements and the hope of maximum success lie in the field of installation.

SPECIAL MEETING OF THE SOCIETY HELD NOVEMBER 21

At the Building Trades Club, 2 Park Ave., New York City on Monday, November 21, at 5:30 p. m., First Vice-President W. T. Jones, Boston, Mass., presided at a Special Meeting of the Society which was held under the provisions of *Article* XIV, *Section* 1 of the By-Laws for the purpose of amending *Article* III relating to Initiation Fees and Dues. Mr. Jones announced the purpose of the meeting and finding a quorum present stated that the meeting was open for business, in accordance with the notice sent to all members.

It was moved by H. G. Issertell, New York, "That *Sections* 1, 2 and 4 of *Article* III of the By-Laws be repealed and that the Initiation Fees and Dues of all grades of membership in the Society shall be as determined by the Council until January 1, 1935."

The motion was seconded by M. F. Blankin, Philadelphia, and approved by vote of the members present. The members in attendance were as follows: H. L. Alt, M. F. Blankin, D. S. Boyden, W. H. Carrier, P. D. Close, Russell Donnelly, G. A. Dornheim, H. B. Eells, M. W. Ehrlich, H. W. Fiedler, H. B. Gombers, C. V. Haynes, W. M. Heebner, C. B. Hotchkiss, H. G. Issertell, E. B. Johnson, W. T. Jones, R. Kuhlmann, F. D. Mensing, A. J. Offner, W. J. Osborn, L. T. M. Ralston, T. W. Reynolds, Clifford Strock, A. E. Stacey, L. A. Teasdale, W. W. Timmis.

NOMINATIONS FOR 1933

The Nominating Committee appointed to select candidates for Officers of the Society for the coming year, 1933, submits the following list of nominees:

For President:

W. T. JONES, Boston, Mass.

For First Vice-President:

C. V. HAYNES, Philadelphia, Pa.

For Second Vice-President:

JOHN HOWATT, Chicago, Ill.

For Treasurer:

D. S. BOYDEN, Boston, Mass.

For Members of the Council:

Three-Year Term

R. H. CARPENTER, New York, N. Y.
J. D. CASSELL, Philadelphia, Pa.
F. C. MCINTOSH, Pittsburgh, Pa.
L. WALTER MOON, St. Louis, Mo.

Respectfully submitted,

NOMINATING COMMITTEE

H. M. HART, *Chairman*

Chapters	*Representative*
Cleveland	C. F. EVELETH
Illinois	H. M. HART
Kansas City	B. NATKIN
Massachusetts	C. P. YAGLOU
Michigan	W. G. BOALES
Western Michigan	S. H. DOWNS
Minnesota	C. E. LEWIS
New York	H. M. WYLIE
Western New York	JOSEPH DAVIS
Ontario	W. G. SHEPPARD
Pacific Northwest	——
Philadelphia	W. ROY EICHBERG
Pittsburgh	F. C. MCINTOSH
St. Louis	C. A. PICKETT
Southern California	L. H. POLDERMAN
Wisconsin	J. G. SHODRON

In accordance with the provisions of the Amended Constitution, as given, ballots containing the names of the above candidates will soon be sent to the membership for voting upon prior to the Annual Meeting in January.

Art. 9—*Section* 2. The Nominating Committee shall consist of a member designated by each Chapter, which shall effect its own organization and elect its own Chairman.

Section 3. The Committee may meet at the call of the Chairman, for discussion, but the official meeting shall be held at the Semi-Annual Meeting of the Society, at which time the candidates for each of the offices of the Society to be filled at the next Annual Meeting shall be selected by a majority vote of the members of the Committee present and voting. Five shall constitute a quorum.

Section 4. The Committee shall first secure the consent of all candidates selected, and shall, if possible, announce the names of the candidates at the Semi-Annual Meeting, but in any case the names of the candidates shall be certified to the Secretary of the Society at least four months before the next Annual Meeting. The Secretary shall publish these names in the October issue of THE JOURNAL.

Art. 10.—*Section* 3. The Secretary shall prepare ballots with the names of all candidates and forward them to the members at least thirty (30) days before the date of the Annual Meeting.

Nominations for Members of Committee on Research

Although committees of the Society are usually appointed, in view of the great importance of the Committee on Research and the financial responsibility it would be called upon to assume, it has been made more representative of the entire membership of the Society by a process of *election*. The election is governed by the By-Laws for the election of officers, with the single exception, that Members of the Committee on Research are nominated by the Council instead of by a Nominating Committee.

In accordance with the Regulations for the Government of the Research Laboratory, adopted at the January, 1919, Meeting, and revised January, 1930, the Council announces the nomination of the following members of the Committee for election to succeed those members whose present terms expire January, 1933:

3 Year Term

ALBERT BUENGER, St. Paul, Minn.
S. H. DOWNS, Kalamazoo, Mich.
H. N. KITCHELL, Cincinnati, Ohio
HOMER R. LINN, Chicago, Ill.
PERRY WEST, Newark, N. J.

1 Year Term

E. N. SANBERN, Philadelphia, Pa.

The regulations governing the nomination and election of members of the Committee on Research are as follows:

SECTION I—ORGANIZATION

Research Committee

1. There shall be a standing committee known as the Research Committee, consisting of fifteen members, each serving for three years, and five retiring each year.

a. The Council shall nominate previous to October first of each year five members to fill the vacancies of those retiring at the next Annual Meeting.

b. The nominations made by the Council shall be published in the October issue of the Society's JOURNAL.

c. Prior to December first of any year, any ten members, over their own signatures, may nominate one or more additional members of the Research Committee, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

d. The election shall otherwise conform to the regulations provided for the election of officers of the Society.

e. Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.

Ohio River from The Pavillion, Alms Park

Cincinnati Plans for A. S. H. V. E.

CINCINNATI will be the gathering point for members of the Society for the 39th Annual Meeting to be held at the Hotel Gibson January 23 to 25, 1933. Subjects for the technical sessions have been tentatively selected and Cincinnati Chapter members are planning a program of entertainment that will be novel and different. Under the guiding hand of W. C. Green, General Chariman, and a corps of live-wire associates, those members who come to Cincinnati will participate in a real big House Party.

The banquet will vary somewhat from the usual formal style and the ladies will find that their time is to be well occupied during the hours that the men are attending tehnical and committee meetings.

It is easy to get to Cincinnati from all parts of the country and the railroads have granted reduced rates (*fare and one-half* for the *round-trip*) under the Identification Certificate Plan. Certificates will be mailed to all members in advance of the meeting so that they may purchase round-trip tickets at reduced rates at their home stations. Hotel reservation cards will also be sent to members prior to the meeting.

In addition to a Technical Program of unusual variety, one of the important topics for discussion at the meeting is to be the Report of the Committee on Constitution and By-Laws. Copies of the present Constitution and the Committee's Report were mailed under date of November 22 to prepare discussions for the Annual Meeting when the subject is to be presented to the meeting on Monday afternoon by First Vice-President W. T. Jones, Chairman of the Committee. The Committee's aim has been to simplify the Constitution and By-Laws and in addition provide a set of Rules for the guidance of Officers and Committees. The fundamental provisions of the present Constitution and By-Laws remain practically unchanged. The Committee has endeavored to coordinate the three main sections so that all matters relating to members election, officers duties, funds, etc., can be readily followed in the Constitution and By-Laws by corresponding numbers, C-I, B-I, R-I, etc.

The Cincinnati meeting offers the members an exceptional opportunity to meet with their fellow engineers and to participate in the discussion of current problems relating to the profession of heating, ventilating and air conditioning.

Cincinnati's industries are noteworthy and large plants manufacture valves and fittings, insulating materials, furnaces, boilers, unit heaters and air conditioning and cooling equipment.

The University is unique among educational institutions through its method of cooperation with the industries of the city and Cincinnati is very proud of this institution and many others which have contributed to civic development and progress.

Cincinnati has an enviable reputation as a hospitable city and the local members of the Society are hard at work on a program to provide a pleasant three days, January 23 to 25.

TENTATIVE PROGRAM 39TH ANNUAL MEETING AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, HOTEL GIBSON, CINCINNATI, JANUARY 23-25, 1933.

Sunday, January 22

10:00 a. m. Meeting of the Council
Meeting of Committee on Research
Other Committee Meetings

Monday, January 23

9:30 a. m. Greetings
Response by Pres. F. B. Rowley
Reports of Officers
Report of Council
Reports of Committees—Finance, Membership, Publication

Walnut Hills High School

TECHNICAL PAPERS
Useful Service of Boilers and Radiators, by C. W. Brabbée
Some Observations on Heating Practice, by James Govan
Report of Tellers

2:00 p. m. Report of Committee on Research
TECHNICAL PAPER
Air Supply and Its Effect on Performance of Oil Burners and Heating Boilers by L. E. Seeley, J. H. Powers and E. J. Tavanlar
Report of Committee on Revision of Constitution and By-Laws by W. T. Jones

7:30 p. m. Discussion of Report of Committee on Revision of Constitution

Tuesday, January 24

9:30 a. m. Report of Guide Publication Committee
TECHNICAL PAPERS
Effect of Cold Walls on the Desired Effective Temperature for Comfort, by F. C. Houghten
Summer Cooling of Residences
(Part I) by A. P. Kratz and S. Konzo
(Part II) by J. H. Walker and G. B. Helmrich

2:00 p. m. Committee on Chapter Relations
TECHNICAL PAPERS
Corrosion in Air Conditioning Equipment and Its Prevention, by R. M. Palmer
Air Supply, Distribution and Exhaust Systems, by S. R. Lewis
Cow-Barn Ventilation, by A. J. Offner
Air Infiltration through Steel Framed Windows, by D. O. Rusk, V. H. Cherry and L. Boelter
Study of the Application of Thermocouples to the Measurement of Wall Surface Temperatures, by A. P. Kratz and E. L. Broderick

4:00 p. m. Meeting of the Nominating Committee
7:00 p. m. Annual Banquet and Dance

Wednesday, January 25

9:30 a. m. TECHNICAL PAPERS
Rate at Which the Return Side of a Practical Steam Heating System Returns Air and Condensate during the Heating-Up Period, by F. C. Houghten
Flow of Condensate and Air in Steam Heating Returns, by F. C. Houghten and Carl Gutberlet
Relative Heat Dissipation from a 6-in. Pipe Carrying Hot Water with Different Kinds of Insulation and Installation of Pipe, by F. E. Giesecke, W. H. Badgett and J. R. Eddy
Installation of Officers
New Business
Resolutions

12:30 p. m. Luncheon Meeting—Council

Ballroom, Hotel Gibson

Honors for Everyone

By G. L. LARSON
Chairman, Committee on Research

TO those who are interested in the success of the 1932 Research Program, it is evident that important contributions were made by many firms and organizations who loaned or donated laboratory equipment and materials. The Committee on Research takes pleasure in acknowledging this generous and helpful cooperation rendered to the Research Laboratory at Pittsburgh and to several of the cooperating institutions:

National Association of Ice Industries
Smithsonian Institution
American Blower Corp.
American Radiator Co.
Brundage Co.
Carrier Engineering Corp.
Crane Co.
C. A. Dunham Co.
Hart and Hutchinson Co.
Hoffman Specialty Co.
Minneapolis-Honeywell Regulator Co.
Modine Manufacturing Co.
Nash Engineering Co.
National Radiator Corp.
National Tube Co.
Herman Nelson Corp.
Reliable Plumbing and Heating Co.
Trane Co.
United States Radiator Corp.

A significant statement of the esteem in which the A.S.H.V.E. Research work is held, came to the Committee on Research in the following letter.

"I now have the pleasure of enclosing our check for $1,000 as the contribution of this Association to the Research Fund of the AMERICAN SOCIETY OF HEATING and VENTILATING ENGINEERS.

"In the course of the summer, I had the pleasure of visiting several of the laboratories at which your research work is being conducted and would like to place on record my high appreciation of the care and accuracy with which the work is being conducted and of its usefulness. At the moment, we have no suggestions to make as to your program, but we will appreciate being kept informed of progress along any line of especial interest to us."

With such expressions of confidence, A. S. H. V. E. members can very well be proud of the work being done by the research organization of the Society.

Warm Air Heating Association to Meet in Urbana

A two-day session is to be held at the Urbana-Lincoln Hotel by the *National Warm Air Heating Association,* December 7 and 8. The Wednesday morning session will be devoted to a discussion of Research Projects by F. G. Sedgwick, Minneapolis, and Prof. A. C. Willard, University of Illinois, and an inspection of the Research Residence and the Mechanical Laboratories of the University will follow. During the afternoon the speakers will be Prof. J. D. Hoffman, who will present the Code Committee Report devoted to Mechanical Warm Air Furnace Heating Systems in Residences, Dean M. S. Ketchum, University of Illinois, Prof. A. C. Willard, Prof. A. P. Kratz and S. Konzo of the University Engineering Experiment Station, and G. D. Kingsland, of Minneapolis, who will speak on Automatic Control.

On Thursday the Results of Tests on Gravity Warm Air Furnaces to Determine Comparative Operating Characteristics With and Without Air Filters will be presented by D. C. Simpson, Columbus, O., the report having been prepared by Prof. F. B. Rowley, director of the Experimental Engineering Laboratories, University of Minnesota. A business forum and discussion will then be held followed by the election of officers.

Officers of Local Chapters

Massachusetts

Leslie Clough
Michigan

Cleveland

R. G. Davis

F. A. Kitchen

L. L. McConachie

G. D. Winans
Western Michigan

Cincinnati

K. A. Wright

G. B. Houliston

D. L. Taze
Minnesota

P. O. Wierenga

Illinois

J. H. O'Brien

J. J. Hayes

W. F. Uhl
New York

Kansas City

W. A. Russell

D. D. Zink

L. T. M. Ralston

T. W. Reynolds

Western New York

M. C. Beman

W. E. Voisinet

Ontario

J. S. Wood

H. R. Roth

Pacific Northwest

C. F. Twist

S. D. Peterson

Philadelphia

L. C. Davidson

W. P. Culbert

Pittsburgh

R. B. Stanger

J. L. Blackshaw

St. Louis

J. M. Foster

C. R. Davis

Southern California

F. R. Winch

E. H. Kendall

Wisconsin

V. A. Berghoefer

C. H. Randolph

New Headquarters for H.P.C.N.Y.C.A.

The *Heating and Piping Contractors New York City Assn., Inc.* announce that their headquarters are now located at Room 1945, Grand Central Terminal, New York City.

R. C. Cosgrove Heads Westinghouse Domestic Air Conditioning

R. C. Cosgrove, manager, refrigeration division, Westinghouse Elec. & Mfg. Co., has been placed in charge of the company's domestic air conditioning activities in addition to his present duties.

Mr. Cosgrove is a graduate of Carnegie Institute of Technology and joined the Westinghouse Company in 1919.

J. J. Donovan Named Director of A. O. B. A.

According to an announcement made by Harry F. Tapp, executive secretary of the *American Oil Burner Assn.*, J. J. Donovan, manager of the air conditioning department of the General Electric Co., New York, N. Y., was elected a director of the association at the regular quarterly meeting of the Board of Directors.

Local Chapter Reports

Kansas City

October 24, 1932. Pres. W. A. Russell called the meeting of the Kansas City Chapter to order at 6:30 p. m. and announced that the featured speaker was to be Prof. F. B. Rowley, President of the Society. The minutes of the previous meeting were read and reports of various committees were given, during which Carl Clegg of the Membership Committee indicated that he had stirred up considerable interest in membership. The report of the treasurer showed that the chapter was in a good financial condition.

Benjamin Natkin raised the question as to whether a number of the younger men were being kept away from Chapter Meetings by the cost of the dinner. It was suggested that a method of reducing this cost be given consideration. E. K. Campbell moved that the matter be taken up by the Board of Governors and their decision in the matter adopted and this motion was seconded and passed.

A report on the Joint Chapter Meeting held at the University of Illinois was given by Mr. Natkin, who stated that some 34 members were present from Kansas City, Chicago, St. Louis and Wisconsin.

The feature of the evening was an address by Prof. F. B. Rowley, president of the A. S. H. V. E., who told of his western trip and outlined some of the present efforts of the Society to keep its activities at their present level.

A paper, entitled Air Conditioning for Human Comfort and Industry, was given by D. D. Zink, secretary.

President Rowley complimented the chapter on its program plan and it was suggested that this idea be passed on to other chapters. The plan was originated by President Russell and developed by the Educational Committee consisting of Prof. A. H. Sluss, H. D. Betz and Mr. Zink.

Michigan

October 17, 1932. Sixty-five members and guests were present at the dinner meeting of the Michigan Chapter held in the Detroit Leland Hotel. After the dinner, Pres. L. L. McConachie asked for a roll call and the reading of the minutes of the May meeting.

W. G. Boales and J. L. Fuller were announced as members of the Committee on Arrangements for the A. S. H. V. E. Semi-Annual Meeting in 1933.

Reports were received from the treasurer and the Membership Committee and H. E. Paetz explained how the meetings of this winter were to be handled.

President McConachie then turned the meeting over to Mr. Boales, who introduced W. G. Malcomson. Mr. Malcomson gave an interesting discussion on the Detroit Building Congress.

Mr. Boales next presented Russel Creviston, who gave a very inspiring talk on Business Promotion.

After a rising vote of thanks to the speakers, the meeting was adjourned.

Western Michigan

October 11, 1932. The Western Michigan Chapter opened the season under the leadership of its new officers at the Rowe Hotel, Grand Rapids.

Before a representative group of members and guests, Samuel H. Ranck, librarian of Grand Rapids Public Library, spoke on the subject of Ventilation of Libraries and Public Buildings. While primarily an educator in library work, Mr. Ranck is also an authority on the problems of this subject, having conducted considerable investigations in typical libraries in many cities and collected data and information for the Committee on Ventilating and Lighting, of which he was chairman, for the *American Library Association*. He cited many of the problems of ventilation that as a whole are found only in libraries, believing that their solution could be attained only by a better understanding of the conditions confronted. The ventilation of a library must be adaptable to unusual requirements such as being capable of changing from light to peak load in a short interval and of shifting proportions of air flow to various parts of the building. There is also the problem of giving comfort to men, women and children and fortunately, the atmospheric conditions best suited to human comfort seem to promote the greatest perpetuation of books.

Mr. Ranck's talk was well received and was followed by comment and discussion.

The meeting was conducted by Pres. D. L. Taze, who outlined the program for the year.

The Western Michigan Chapter is proud of having its member, S. H. Downs, of Kalamazoo, nominated for a member of the Committee on Research of the Society.

Committee reports gave evidence of effective and thorough work and the chapter has every reason to expect that the year will be successful, instructive and enjoyable.

Minnesota

October 10, 1932. The second meeting of the 1932-33 season was held in the Banquet Room of the Minneapolis Y. M. C. A. with 67 members and guests attending. The chapter had extended invitations to the members of the *American Institute of Architects* and the *Heating and Piping Contractors Association* to join with them in hearing J. F. McIntire, of Detroit, Michr., who had made a special trip to Minneapolis at the invitation of the chapter.

Dinner was served at 6:15 o'clock and the meeting was called to order a short time later by Pres. W. F. Uhl. The minutes of the previous meeting were read and approved and the secretary, C. E. Lewis, was called upon for a report on the action of the Board of Governors on local chapter dues. Mr. Lewis also asked the members to pay their national society dues without further delay. Committee reports were given by their respective chairmen and a preliminary announcement was made regarding the Fall Party to be held in November.

Routine business was quickly disposed of and, prior to the introduction of the guest speaker, a film, prepared by Baron Shiba of Japan, on High Speed Photography was shown. The pictures demonstrated air movement through orifices and also bullets in flight. The exceptionally high speed at which they were taken and the large number of exposures per unit of time showed a new field in research about to be opened.

The guest speaker, Mr. McIntire, was introduced by W. N. Parks, and the subject of his talk was The Development of Concealed Cast Iron Radiation. As an introduction, he traced the development of the concealed radiator in Europe, especially the cast-iron type. The low cost of labor in the making of patterns and castings made possible very interesting mural decorative radiators. This country has been slow to take up concealed radiation, he said, and due to the pecularities of our residence construction, radiation must be manufactured to go into very narrow spaces.

To produce the radiators in cast iron to meet modern requirements of construction it was necessary to improve the technique of core construction and casting. By careful laboratory research and checking of operations, it is now possible to economically cast extremely thin sections and to core up such castings at a low cost, he pointed out. This combination has made possible the production of the new types of radiators with continuous metal construction of waterway and fin.

Ontario

November 7, 1932. The Prince George Hotel, Toronto, was the meeting place of members and guests of the Ontario Chapter on November 7.

Following dinner, Pres. J. S. Wood announced that the chapter was to select a member and alternate for the Nominating Committee of the National Society. It was moved by W. P. Boddington, seconded by J. S. Paterson, and carried that the nomination be referred to the Board of Governors.

G. A. Playfair of Toronto was the principal speaker of the evening and was introduced by President Wood. Mr. Playfair presented a motion picture showing Temperature Control Systems. A vote of thanks was extended to him by Thomas McDonald, expressing the appreciation of the chapter for the very instructive film.

October 3, 1932. The first regular meeting of the Ontario Chapter was held at 6:00 p. m. at the Prince George Hotel with 21 members present.

The activities of the chapter for the coming year were outlined by Pres. J. S. Wood and reports were made by the Membership and Attendance Committees.

After the regular business was attended to, the members adjourned to spend a pleasant evening of bowling.

Philadelphia

October 13, 1932. Members and guests of the Philadelphia Chapter assembled at the Engineers Club, where they were called to order by Pres. L. C. Davidson.

Prior to the dinner, H. G. Black introduced B. F. March, traffic engineer for the City of Philadelphia, who spoke briefly on the work of the Philadelphia Technical Service Committee.

The minutes of the previous meeting and the treasurer's report were read and approved.

It was announced that during the summer months the chapter had lost three of its members through death, namely, L. J. Sommer, P. E. Sowers and J. J. Brogan. A committee, consisting of Karl Rugart, J. H. Hucker and W. F. Smith was appointed to prepare suitable resolutions.

Mr. Black explained briefly the part that the chapter should take if the work of the Philadelphia Technical Service Committee is to be carried on and J. D. Cassell also appealed for the support of this employment drive.

A short talk was given by F. D. Mensing, regarding the financial condition of the Society.

Mr. Cassell spoke of the action that the Council of the Society is taking to keep the organization on a paying basis and to maintain its present membership.

W. R. Eichberg, chairman of the Meetings Committee, introduced T. A. Novotney, Johnstown, Pa., who presented a paper on The Design of Convection Heaters. This presentation was acclaimed by several members to be one of the best in some time and a rising vote of thanks was given to Mr. Novotney for the manner in which he handled the subject.

After a general discussion, the meeting was adjourned.

Joint Chapter Meeting at University of Illinois

A joint meeting of the Illinois, Kansas City, St. Louis and Wisconsin Chapters of the A. S. H. V. E. was held at the University of Illinois, Urbana, Ill., on Saturday, October 15. Thirty-five visitors from 10 cities were present and inspected the research work in heating and ventilation, which is now in progress at the University.

The following members and guests were in attendance during the day: from Chicago, C. W. Adams, C. M. Baumgardner, W. M. Brayton, L. W. Britton, E. W. Gifford, R. B. Hayward, H. R. Linn, R. V. Pfautsch, S. I. Rottmayer, J. L. Rowe, R. W. Shields, L. B. Spafford, Theodore Weinshank; from Kansas City, E. K. Campbell, Carl Clegg, Benjamin Natkin, Bert Natkin, W. A. Russell, F. A. Sheppard, C. A. Weiss, D. D. Zink; from St. Louis, J. M. Foster, L. W. Moon, Eugene Morean, W. S. Newberger, C. E. Parmelee, A. L. Walters; and L. R. Szombathy, Ferguson, Mo., R. A. Seepe, Indianapolis, Ind., N. J. Betourne and A. P. Ducharme, Kankakee, Ill., A. H. Sluss, Lawrence, Kansas, E. A. Jones, Milwaukee, Wis., G. B. Supple, South Bend, Ind., and F. B. Sido, Springfield, Ill.

During the morning, the research staff, engaged in heating and ventilating investigations, conducted the visitors through the Mechanical Engineering Laboratory and the Research Residence for an inspection of the following research projects: Warm Air Furnace Testing Plant, Low Temperature Plant for Radiator Tests under Service Conditions, Radiator Testing Booth, Stoker Fired Boiler, Mechanical Warm Air Heating Installation and the Summer Cooling Plant.

After witnessing the football game between Illinois and Northwestern, the members assembled at the Mechanical Enginering Laboratory Lecture Room in the evening to discuss the more important phases of the various research projects, which had been inspected in the morning. Prof. A. C. Willard welcomed the visitors and Prof. A. P. Kratz presented a brief survey of the summer cooling project carried on during the past summer and led the discussion which developed from his talk. Following this discussion, S. Konzo gave a similar survey of the mechanical or forced-air heating and conditioning project, which is also being conducted in the Research Residence. This work is a continuation of the warm air furnace research program of the past 15 years. More discussion ensued and finally Prof. M. K. Fahnestock reviewed the direct steam and hot water heating investigation which has been in progress in the low temperature testing plant and warm wall booth in the Mechanical Engineering Laboratory for the past seven years.

Every effort was made to have the visitors see and discuss all phases of the research work which is being sponsored by the A. S. H. V. E. and the *National Warm Air Heating Association*. The research staff wishes to express its pleasure in having this first joint chapter meeting held at the University of Illinois and in the opportunity which was afforded for making personal contacts and acquaintances with so many members of the Society.

Refrigerating Engineers Meeting in New York

The 28th Annual Meeting of the *A. S. R. E.* will be held in the Hotel New Yorker, New York City, December 7-9, during which time five technical sessions are to be held. The opening session, at which Pres. Glenn Muffly will preside, is to be devoted to a discussion of Air Conditioning Practice and the subjects to be discussed are Water as a Refrigerant, by John Everetts, Jr., New York, Comfort Cooling with Ice in 1932, by George B. Bright, Detroit, and Air Conditioning Theory: Classroom Methods of Presentation, by Prof. J. A. Goff, University of Illinois.

A. S. M. E. Meeting in December

The 53rd Meeting of the *American Society of Mechanical Engineers* is to be held in the Engineering Societies Building, New York, December 5-9. Group sessions are to be held each day and one of special importance to engineers interested in heating and ventilating work is to be held at 2:30 p. m., Monday, December 5, and will be devoted to a discussion of a Proposed Test Code for Centrifugal Compressors, Exhausters and Fans and two technical papers on fan testing and air flow. H. F. Hagen will present a paper entitled, Pulsation in Air Flow from Fans and its Effect on Test Procedure, and a paper entitled, Influence of Bends in Inlet Ducts on the Performance of Induced-Draft Fans, will be given by L. S. Marks, J. Lomax and R. Ashton.

The Society is cooperating with the *A. S. M. E.* in the sponsorship of the Monday afternoon session and, for the benefit of members who plan to attend, reduced fare railroad certificates should be obtained when buying tickets to New York.

Death of Paul E. Sowers

On October 8, 1932, the Society lost one of its members in the death of Paul E. Sowers, who was a native of York, Pa., having been born there on June 21, 1892, and who was elected to membership in the A. S. H. V. E. in November 1922.

Mr. Sowers gained most of his engineering knowledge from practical experience, having started his career as an apprentice machinist and steamfitter. At one time he was superintendent of construction for the York Heating & Ventilating Co., York, Pa., and from 1917-1918 saw service with the U. S. Navy French Aviation Construction Unit. He had specialized in vapor heating and was heating engineer and branch manager of the York Office of the Vapor Heating Co., prior to acting as manager of the firm of Paul E. Sowers Co., which was organized in 1929 as engineers and manufacturers representatives with offices in the Manufacturers Association Building at York.

Mr. Sowers is survived by his widow and two sons, to whom the Officers and Council extend their sincere sympathy for the loss which they have sustained.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Membership Committee as soon as possible.

When the Membership Committee has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 7 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Membership Committee, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some members by December 15, 1932, these candidates will be balloted upon by the Council. Those **elected to membership will be notified by the Secretary immediately after election.**

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
CANNON, C. NEWTON, Graduate Student, Purdue University, W. Lafayette, Ind.	W. T. Miller (*Non-Member*) J. C. Peebles (*Non-Member*)	H. G. Venemann (*Non-Member*) G. F. Gebhardt (*Non-Member*)
DALLAVALLE, J. M., 829 E. Knapp St., Milwaukee, Wis.	Philip Drinker C. P. Yaglou	Theodore Hatch (*A. S. C. E.*) Lawrence Fairhall (*Non-Member*)
ELLIOTT, LOUIS, Cons. Mech. Engr., Electric Bond & Share Co., New York, N. Y.	A. M. Feldman E. D. Harrington	P. S. Lyon C. W. Obert
FAGIN, DANIEL J., Laclede Gas Light Co., St. Louis, Mo.	G. A. Helwig Wm. D. Thompson (*Non-Member*)	L. W. Moon R. M. Rosebrough
MITTENDORFF, EDWARD M., Sales Engr., Sarco Co., Inc., Chicago, Ill.	E. J. Ritchie E. E. Wells	A. O. May T. N. Adlam
STILLER, F. W., Estimator & Supervisor, F. C. Stiller & Co., Minneapolis, Minn.	D. M. Forfar C. E. Lewis	E. F. Jones Albert Buenger
TIMMIS, W. WALTER, Mgr., C. A. Dunham Co., New York, N. Y. (*Advancement*)	Alfred L. Jaros, Jr. (*Non-Member*) L. T. M. Ralston	W. H. Driscoll C. E. Langgaard (*Non-Member*)

Candidates Elected

In past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Membership Committee and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. II, Sec. VIII, of the By-Laws, the following list of candidates elected:

MEMBERS

HUST, CARL E., Htg. Engr., Union Gas & Elec. Co., Cincinnati, O.

LANDERS, JOHN J., U. S. Radiator Corp., Buffalo, N. Y. (*Reinstatement*)

SIMPSON, DONALD C., Devp. Engr., Supt. of Research, Owens-Illinois Glass Co., Columbus, O.

WARING, J. M. S., Partner, Chase & Waring, New York, N. Y.

ASSOCIATES

CHARLTON, JOHN FELDER, Valuation Engr., Ft. Lauderdale, Fla.

COOMBE, JAMES, Vice-Pres., The Wm. Powell Co., Cincinnati, O.

JUNIOR

RINEHART, WILSON R., Engr., W. F. Hirschman Co., Le Roy, N. Y.

Index to Vol. IV—January-December, 1932 Heating, Piping and Air Conditioning

Air Conditioning—General

Air Conditioning Is Saving Industry $15,000,000 Yearly, by Willis H. Carrier.
No. 12. *December,* 1932. *p.* 785.
Climate's effect on man; industrial development of air conditioning; two types; air conditioning ups production, downs cost; saving in cigar plant; estimated saving to industry; economic aspect of industrial air conditioning; future of comfort conditioning; why humans need conditioned air; research; theater system pays first summer; pays in stores; office buildings save; railroads; homes; development of tropics; what air conditioning means to business and employment. 10 i.

Lay-Out of a Zoned Air Conditioning System, by Ralph E. Phillips and Donald T. Robbins.
No. 1. *January,* 1932. *p.* 12.
Los Angeles Stock Exchange building; exposures and nature of occupancy make zoning necessary; conditions maintained; location of equipment; control and recirculation; boilers are oil-fired; heating system two-pipe vacuum return down-feed; amount of air; cost of power; cost of installation, diagram of chilled water and condensing water piping. 9 i.

Conditioning System Planned to Enable Operating Economies, by Chester L. Nelson.
No. 3. *March,* 1932. *p.* 171.
Air conditioning equipment in New York Curb Exchange building; new section added; sources of heat; conditions maintained; trading floor equipment; air filtered and ionized; instruments; conditioning the clearing house; refrigeration and water piping; cold water storage tank cuts cost of refrigeration; interchanger; air for pneumatic tube system dehumidified. 5 i.

20-Story Building Humidified in Winter, Cooled in Summer, by H. D. Nock.
No. 10. *October,* 1932. *p.* 675.
Mutual Home Building, Dayton, Ohio, air conditioned; contains banking and office space; the building; 56-F water from deep well used; district steam; reasons for air conditioning; ducts; two-speed motors drive fans; temperature and humidity control; location of equipment; thermostat controls damper; each exposure separately controlled; central riser chamber for piping and ducts; space between joists for branch ducts; outlet cabinet at each window; control of cold water; cost of winter and summer operation. 4 i.

Air Conditioning Needs of Hospitals Specified, by Dr. C. A. Mills.
No. 4. *April,* 1932. *p.* 275.
Needs for air conditioning in hospitals described and listed.

Shanghai Has Air Conditioned Building, by Cyril L. Tilburn.
No. 2. *February,* 1932. *p.* 120.
Mechanical equipment of Sassoon House, Shanghai, China; forced hot water heating system; domestic hot water; the boiler plant; refrigeration plant; air conditioning. 6 i.

Improved Inverted-Refrigeration Cycle for Summer-and-Winter Air Conditioning, by H. J. Stoever.
No. 6. *June,* 1932. *p.* 412.
Operation of a Carnot-cycle plant; performance measured by coefficient; performance of actual plant differs from ideal; cycle which improves ideal coefficient; its coefficient of performance; theoretical result obtained with vapor cycle; method of approximating cycle; approach to cycle uses several condensers; air-conditioning engineers should recognize that cycle operating between two fixed temperatures is not the ideal. 9 i.

Reversed Refrigeration Cycle Heats Office Building.
No. 6. *June,* 1932. *p.* 415.
Brief description of reversed-refrigeration cycle for heating office building of Southern California Edison Co., Los Angeles. 1 i.

Knowledge of Electrical Fundamentals Saves Costly Mistakes, by Milton K. Arenberg.
No. 3. *March,* 1932. *p.* 199.
Specifying the motor; direct current; alternating current; phase; types of alternating current motors; miscellaneous points to remember. 3 i.

Attention to Maintenance of Motors Saves Money.
No. 10. *October,* 1932. *p.* 664.
Motors need attention; causes of losses in motors; motors driving centrifugal pumps and fans; protective devices; speed-reducing transmissions; ammeter readings and shifting motors keep power cost down; illustrations show uses of various types of motors. 10 i.

Determining Air Velocity with High-Temperature Kata, by T. C. Angus.
No. 5. *May,* 1932. *p.* 394.
Determination of effective temperature thermal index requires air velocity to be found at point under consideration; new kata thermometer for use in industrial buildings having high air temperatures; formula for air velocity; chart gives result graphically. 1 i.

Interest in Air Conditioning Is World-Wide.
No. 8. *August,* 1932. *p.* 556.
Letters from South Africa and Brazil requesting information on air conditioning for human comfort.

Modernize Heating, Piping and Air Conditioning Systems for Efficiency and Economy—the Air-Conditioning System.
No. 11. *November,* 1932. *p.* 737.
Check-list and maintenance guide for air-conditioning systems.

Air Conditioning—Cleaning

A Review of Dust, by L. B. Spafford.
No. 1. *January,* 1932. *p.* 33.
Why and what the engineer should know about dust; what dust is; where it is; useful and objectionable dusts. 1 i.

Size and Characteristics of Air-Borne Impurities, by W. G. Frank.
No. 1. *January,* 1932. *p.* 35.
Origin of dust suspensions; measuring dust particles; surface mean diameter; volume mean diameter; dust chart classifies laws of settling, etc.; laws of settling; Brownian movement; permanent and temporary impurities; fumes; smoke; explosive dust suspensions; fighting atmospheric pollution; bibliography. 2 i.

Air Conditioning Detroit Edison Research Building, by J. N. Livermore and P. S. Hosman.
No. 9. *September,* 1932. *p.* 593.
Necessity for air conditioning; clean air prime requisite; refrigeration; determining maximum cooling load; reduce cooling load by venting roof; roof construction; ventilators; central cooling system with zoned ducts; compressor and motor; cold water tank carefully insulated; how one pump does work of two; keeps slugs of ammonia from suction line; refrigeration plant also used for testing work; control equipment centralized. 8 i.

Air Conditioning—Cooling

Cost of Cooling an Office Building.
No. 2. *February,* 1932. *p.* 109.
(Abstracted from paper by S. R. Lewis presented at meeting of *Western Society of Engineers*); 40-story office building analyzed; cost per sq. ft. of heating system, ventilating system, and cooling system.

Office Conditioned Economically With Unit Coolers, by Clifford F. Holske.
No. 2. *February,* 1932. *p.* 98.
Ice-cooled air conditioning system installed in offices of Knickerbocker Ice Co., Freeport, N. Y.; cost of installation and operation; conditions maintained; water cooling tank; the unit coolers; fans. 2 i.

Water Coolers for Air-Conditioning Systems Using Ice, by Clifford F. Holske.
No. 6. *June,* 1932. *p.* 405.
Figuring size and capacity of ice bunker; construction; typical methods of construction; water piping; control of water temperature; overflow. 4 i.

Small Theater Solves Air-Conditioning Problem With Ice.
No. 5. *May,* 1932. *p.* 353.
Layout of ice-cooled air-conditioning system in a small movie theater; control of water; cooling chamber; capacity of plant; automatic control; diagram of equipment. 2 i.

"Twenty Degrees Colder Inside," by E. Roger Hewitt.
No. 9. *September,* 1932. *p.* 630.
Tables aid in maintaining proper air conditions in theaters; use of the tables.

Keeps Patrons Cool With Ice, by Clifford F. Holske.
No. 8. *August,* 1932. *p.* 538.
Occidental Hotel, Washington, D. C., installs air-condiioning system for dining rooms; equipment; ducts installed without interruption to operation; cold water controlled by electrically-operated valve; typical amounts of ice delivered; water piping; cooling load; tests show results; management well-pleased. 5 i.

Compressors for Air Cooling Located in Elevator Pits, by F. F. Sengstock.
No. 2. *February,* 1932. *p.* 100.
Air cooling system installed for restaurant in Merchandise Mart, Chicago; size of restaurant; the carbon-dioxide compressors and the motors; lay-out of refrigeration equipment in elevator pits; direct expansion coils in ducts; pipe joints welded. 6 i.

Installs Cooling System June 1; Summer's Business Increases 60%.
No. 11. *November,* 1932. *p.* 734.
Steam ejector air-cooling system in Maurice's restaurant, Chicago; reasons for air conditioning; operation; cooling restaurants; conditions maintained; thermostat; steam, water and power required. 2 i.

Does Cooling Pay?
No. 9. *September,* 1932. *p.* 651.
Chart shows relation between business done in air-conditioned Chicago restaurant and outside dry-bulb temperature; two curves very similar. 1 i.

Car Conditioning Developing Rapidly.
No. 4. *April,* 1932. *p.* 261.
Importance of railway car air conditioning and its possibilities; history of passenger car heating and ventilating; methods of heating; heating cars in yards and in motion; pre-cooling; cooling with ice; early experiments; factors to consider; the various systems described and diagrammed. 11 i.

Pre-Cooling Fruits and Vegetables With Circulating Air, by Clarence E. Baker.
No. 1. *January,* 1932. *p.* 42.
Importance of pre-cooling; its value; heat generated by fruits; methods of pre-cooling; bibliography. 2 i.

Air Conditioning—Humidifying and Dehumidifying (Including Drying)

Benefits—Not Cost—Decided This Complete Air-Conditioning Plant, by E. L. Ellingwood.
No. 8. August, 1932. *p.* 550.
Air conditioning system in Times-Mirror Printing and Binding House, Los Angeles, Calif.; reasons; entire building conditioned; constant dew-point maintained; control; the equipment; soundproof fan and motor platform detail. 3 i.

Newspaper Plant Air Conditioned for Efficient Production, by Joseph A. Osborn.
No. 1. January, 1932. *p.* 40.
Press-room in new building of St. Louis Globe-Democrat humidified; radiation; use of condensate for building hot water supply conserves heat; district steam used; individual exhaust systems. 5 i.

A Method of Conditioning Paper, by John A. Masek.
No. 7. July, 1932. *p.* 491.
(On the Job); paper web conditioner in newspaper press-room vaporizes water with compressed air; water vaporized; installation; advantages. 2 i.

Effect of Relative Humidity on Cellophane.
No. 7. July, 1932. *p.* 486.
Two types; storage of Cellophane; relative humidities in cigar plant using Cellophane for wrapping.

Drying—An Essential Process in Industry, by Walter L. Fleisher.
No. 11. November, 1932. *p.* 719.
Thermodynamics of leather drying; air lost by leakage; methods of drying leather; the time element; typical example worked out; conditions should be automatically controlled.

Drying Method Is All-Important, by Malcolm Tomlinson.
No. 2. February, 1932. *p.* 116.
Unit effect of humidity, pressure and temperature shown by charts; use of charts in solving drying problems; four general drying methods; drying with air; importance of proper method; drying lumber offers opportunities for economy; physical structure of product influences the drying method. 11 i.

Calculations for Drying, by Malcolm Tomlinson.
No. 4. April, 1932. *p.* 276.
Method of computing heat required; specific heat of various materials; calculations for drying a typical electrical product; product must be sealed against moisture regain; harmful effect of temperature depends upon time; three-stage drying of beets (detailed calculations); charts for high-temperature drying; low-humidity psychrometric charts; Grosvenor psychrometric chart. 7 i.

Removal of Moisture From Precipitates—Drying Zinc Stearate, by Malcolm Tomlinson.
No. 5. May, 1932. *p.* 393.
Fundamenals of removing moisture from chemical precipitates; selecting the drying method; example for zinc stearate.

Economy in Drying Aided by Vapor Proofing, by Malcolm Tomlinson.
No. 7. July, 1932. *p.* 482.
Need for barring moisture flow through walls of low-humidity rooms; moisture equilibrium; vapor pressure; wall construction; typical case; method of vapor proofing.

Prevents Damaged Goods, Rusty Machinery, by Ralph Winslow.
No. 8. August, 1932. *p.* 543.
Roof insulation stops condensation and drip; chart makes easy figuring; need for such prevention; roof insulation of textile mill; paper plant prevents spoilage; chart shows economical thickness of corkboard; roof resistance table. 2 i.

Uses Pipe Caps in Repairing Air Washer, by Lawrence H. Georger.
No. 11. November, 1932. *p.* 745.
(On the Job); pipe caps installed in air washer prevent spray back lash; method of using. 1 i.

Air Conditioning—Ventilating

Preventing Air Pollution in the Plant, by John H. Ruckman.
No. 5. May, 1932. *p.* 356.
Numerous substances and materials tend to pollute the air in plants; use of such materials increasing; chronic pollution; supplying fresh air to working stations; use of hoods; importance of proper air circulation; use of partition; dusts and fog; classification of objectionable materials. 7 i.

Low-Cost Protection of Fur Storage Vault, by Milton K. Arenberg.
No. 5. May, 1932. *p.* 338.
Carbon tetrachloride used as fumigant in fur vault, Boston Store, Chicago; the vault; handling the furs; ventilating equipment; introducing the fumigant; operating costs and results. 2 i.

Ventilating System Designed for Efficient Operation, by George W. Ott.
No. 7. July, 1932. *p.* 487.
New Chicago postoffice built over railroad tracks; removing locomotive smoke; smoke trough over tracks; lobby air circulated through booster heaters; air may be exhausted at floor or ceiling to promote comfort; 1,500 tons of ducts; heater stacks pneumatically controlled; fans have 6 per cent excess capacity for leakage; induction motors drive fans with V-belts; complete system of temperature control. 3 i.

Estimating Duct Work for Louisiana State Capitol Building Air-Conditioning System.
No. 6. June, 1932. *p.* 418.
Schedules worked out for sheets; estimating sheet metal required; schedules for angles, inserts, hanging and bracing; conditioning system described briefly. 1 i.

Heating, Piping and Ventilating Where Requirements Are Severe, by Junius D. Edwards.
No. 7. July, 1932. *p.* 479.
Aluminum Research Laboratories, New Kensington, Pa.; ventilation major problem; fans and motors on roof; baffle plate in hood distributes suction; heat conserved by drawing air through hoods from building; metal-covered pipe chases on outside walls; drain pipes arranged for easy cleaning; distilled water in aluminum piping; vapor-vacuum heating system; aluminum paint on piping. 4 i.

Chart Helps Duct Changes, by George T. Condron.
No. 8. August, 1932. *p.* 555.
(On the Job); chart for low-pressure air flow in ducts based on quantity of air flowing; shows loss of head, air flowing and dimensions of circular or rectangular ducts; use of chart; basis of chart. 1 i.

"Open For Discussion."
No. 1. January, 1932. *p.* 84.
Comments by S. R. Lewis and A. C. Willard on "Turning Blades Reduce Duct Elbow Losses," by F. E. Wertheim (November, 1931, issue); closure by F. E. Wertheim; comparison of Loring Wirt and B. L. Spivak formulas; efficient and inefficient elbows. 6 i.

The Control of Motors Driving Ventilating Fans, by Samuel R. Lewis.
No. 12. December, 1932. *p.* 794.
Energy requirements of fans; motors must have excess capacity for some types; tendency to locate fans near areas served requires remote control arrangements; operations which must be controlled; starting equipment; controlling unit ventilators in office building; diagrams for various control arrangements. 3 i.

Choosing a Multi-V Drive for a Fan.
No. 9. September, 1932. *p.* 615.
Information needed; five belt cross-sections; number of belts; load characteristics; sheave diameters; arc of contact; typical fan drive selected from manufacturer's literature. 2 i.

Spot Welding Stainless Steel Sheets, by V. W. Whitmer.
No. 10. October, 1932. *p.* 669.
(On the Job); stainless steels well adapted to spot welding; pressure has effect on weld; the welding procedure; reducing depression in sheet; oxide formed is surface condition.

Air Velocity and Acoustics, by E. F. Ries.
No. 1. January, 1932. *p.* 89.
Comments on effect of humidity and velocity of air on acoustics; lining ducts. 1 i.

Total, Static and Velocity Pressure, by A. A. Berestneff.
No. 3. March, 1932. *p.* 195.
Definitions of total, static and velocity pressure; misconceptions sometimes made; various cases illustrated; references analyzed; conclusions. 6 i.

Determining Total, Static and Velocity Pressure, by L. A. Harding.
No. 4. April, 1932. *p.* 324.
("Open for Discussion"); comments on "Total Static and Velocity Pressure," by A. A. Berestneff, March, 1932, issue; definitions of the terms; case of fan connected to inlet and outlet ducts considered; pressures shown by diagram. 1 i.

Heating—General

Heating the Tall Building, by Joseph W. Degen.
No. 9. September, 1932. *p.* 602.
Effects of chimney action in tall buildings on the heating; studies made in the Equitable Building, New York City; data on radiation; draft-gage readings show pressures on various floors; pressure difference used for ventilation; radiator count shows effect of chimney action; north exposure had no effect on number of radiators turned on. 10 i.

Heating-Up Load for Buildings Heated Intermittently, by John M. Robertson.
No. 5. May, 1932. *p.* 341.
Importance of load on heating plant due heat for warming the building construction; churches present severe problem; determine rate at which building materials absorb heat; typical curves; 4 F per hr. average temperature rise assumed; load varies with type of construction; heating-up load for a field house; no relation between heat loss and heating-up load; graphic comparisons of heat loss and heating-up load for four buildings. 5 i.

Heating-Up Load for Buildings Heated Intermittently, by E. K. Campbell.
No. 6. June, 1932. *p.* 420.
(Open for Discussion); comments on article in May, 1932, issue; two elements involved; article contains "experience" data.

Modernize Heating, Piping and Air Conditioning Systems for Efficiency and Economy—Plant and Building Heating Systems.
No. 12. December, 1932. *p.* 797.
Check-list and maintenance guide for steam, vacuum, vapor, hot-water and warm-air heating systems and buildings served by district steam.

Changing the Nomenclature of Heating Engineering, by B. S. Harrison.
No. 3. March, 1932. *p.* 251.
Comments on heating nomenclature.

Heated and Ventilated Poultry Houses Have Many Advantages, by Frederic L. Campbell.
No. 3. March, 1932. *p.* 204.
Advantages of properly heated and ventilated poultry houses; proper conditions to maintain. 1 i.

Heating—District and Central (Including Underground Steam Piping)

Mile-Long Underground Line Supplies Steam for Process, by Robert L. Fitzgerald.
No. 3. March, 1932. *p.* 180.
Steam supplied Eli Lilly Company from Indianapolis Power & Light Co.; amount; condition of steam; factors affecting size of line; construction details; depth; location; insulation; cross-section of tile conduit; factors affecting insulation; covering used; conduit; pipe; expansion; line will act as surge tank. 4 i. (Also see May and June, 1932, issues.)

Underground High-Pressure Steam Piping, by J. E. Hillemeyer.
No. 5. May, 1932. p. 354.
(Open for Discussion); comments on article "Mile-Long Underground Line Supplies Steam for Process," March, 1932, issue; location of vitrified tile block; insulating rollers shows appreciable saving; placing high-pressure traps in separate manholes; place reducer past turn. 1 i.

Heat Loss From Underground Steam Lines Tested.
No. 11. November, 1932. p. 730.
Thirteen miles of new underground mains tested for heat loss; results.

Steam Consumption of Buildings.
No. 9. September, 1932. p. 631.
Tables showing average steam consumption of various types of buildings in Indianapolis, Ind., using central station steam; cost in cents per sq. ft. radiation.

Heating—Steam, Vacuum, Vapor, Hot Water

Selecting the Right Size Heating Boiler, by Sabin Crocker.
No. 2. February, 1932. p. 103.
Selection of right size boiler depends on at least eight items; absorbing capacity of boiler surface; manufacturers' ratings; computation of load due to connected radiation; bare and covered piping; domestic hot water requirements; tables and curves for heat emission and condensation factors for radiation, variation with pipe size of rate of heat transfer through 85 per cent magnesia and bare pipe, heat emission through horizontal bare iron and steel pipe, piping "tax" for several buildings, water heating loads, and heating power of brass and iron pipe coils in water storage tanks. 4 i.

Selecting the Right Size Heating Boiler, by Sabin Crocker.
No. 3. March, 1932. p. 186.
Satisfactory warming-up period and its importance; warming-up allowance; general rule; computing time required for warming up a system; typical weights of boilers and water content, pipe, screwed and flanged fittings, radiators; time required for warming-up period for one-pipe steam system and two-pipe gravity hot water system computed in detail; solution of problem by formula and chart; use of performance curves recommended; typical curves. 3 i.

Selecting the Right Size Heating Boiler, by Sabin Crocker.
No. 4. April, 1932. p. 267.
Fuel-burning and its importance; practical combustion rates; hand-fired boilers; stoker-fired boilers; setting heights; oil-fired boilers; gas-fired boilers; comparison of two gas-fired jobs. 5 i.

Clean Boilers Save Fuel, by G. L. Davis.
No. 9. September, 1932. p. 620.
(On the Job); clean boiler heating surfaces necessary to heating plant economy; how soot cuts heat transfer shown pictorially; test run on boiler before and after cleaning tubes; results shown graphically; fuel saved. 2 i.

Soot Blower Makes a 14½% Fuel Saving, by G. L. Davis.
No. 4. April, 1932. p. 274.
Saving made by Belcrest Hotel, Detroit, by installating air-operated mechanical soot blower; operation. 2 i.

Zone Control of Radio City Heating System, by W. Walter Timmis.
No. 5. May, 1932. p. 335.
General features of Rockefeller Center, New York City; the center tower building; method of zoning the vacuum-heating system; control; orifices insure proper circulation of steam. 5 i.

Piping Changes Made Without Harm to Service, by Samuel R. Lewis.
No. 2. February, 1932. p. 111.
How the heating plant in an office building was rejuvenated without shutting system down; two-pipe vacuum system installed; heating the building during the changes; elevations and plans of piping and traps, with new radiators and unit ventilating machines. 3 i.

Promoting Operating Economy in School Plants, by John Howatt.
No. 1. January, 1932. p. 1.
Economies must not impair service; design; ten-year fuel consumption records for Chicago public schools; the boiler load; typical daily load curve; seasonal fuel consumption; types of boilers used; fuel cost; furnace maintenance cost; cooling-off rate of building; shades; weatherstripping; instructions for operating engineers. 6 i.

Trouble-Shooting a Noisy Heating Job, by William Goodman.
No. 10. October, 1932. p. 680.
Concealed radiator supply branches in apartment building trapped; locating the trouble without tearing out walls; correcting the trouble; cause of the trouble. 5 i.

Modernized Department Store Heating System Cuts Cost.
No. 6. June, 1932. p. 460.
(On the Job); Hutzler Brothers' department store, Baltimore, Md.; 5,000,000 cu. ft. heated by gravity steam-heating system; control; operating procedure; divided into 7 zones; steam consumption, heating load, operating rate, etc., tabulated. 1 i.

Saves 18% on Heating Cost, by H. G. Thomas.
No. 11. November, 1932. p. 744.
(On the Job); how a check-up was made of a vacuum-heating system; saving made.

Locating "Vacuum Pump" Troubles, by John A. Masek.
No. 5. May, 1932. p. 350.
Apparent pump troubles often caused by piping or specialties at fault; air leakage; radiator traps and valves; re-evaporation of condensate; pumping condensate; lift fittings; elimination of water in discharge line; boiler compounds; cutting out the pump; proper placing of check valves; float mechanism of pump; vent or overflow pipe over motor; typical vacuum pump service calls; suction lift curves for hot water. 4 i.

Economies With Vacuum Pumps, by George T. Condron.
No. 7. July, 1932. p. 492.
(On the Job); possible economies from installing vacuum pump on steam-heating system return; evaluating the expected saving.

New Postoffice a Great Industrial Work-Space—Heated by Steam and Hot Water, by George W. Ott.
No. 6. June, 1932. p. 401.
Description of Chicago, Ill., postoffice building; handling the mail; steam purchased; radiation; hot-water converters and pumps; unit heaters in trucking space; condensate preheats domestic water; economizer; pipe materials and connections; piping runs exposed; pressure-reducing valves; sound isolation of equipment; pipe insulation. 2 i.

Cuts Heating and Compressed-Air Cost With Waste-Heat Boilers, by Thomas R. Shaver.
No. 11. November, 1932. p. 728.
Use of waste-heat boilers; installation in Belle City Malleable Iron Co. plant, Racine, Wis.; steam from waste-heat boilers drives air compressors; exhaust steam heats water circulating through pipe coils; one boiler direct fired at night; water circulating pump turbine driven; the piping. 6 i.

Saves Fuel by Equalizing Flow in Hot-Water Heating Systems, by Erwin L. Weber.
No. 9. September, 1932. p. 608.
Gravity circulation systems tend to equalize; forced systems do not; example shows annual loss of $1.35 per radiator on unbalanced system; economics of equalization; thermocouples determine temperature drop through radiators; method of equalizing water flow. 1 i.

Electric Control of Motor-Driven Pumps, by Samuel R. Lewis.
No. 11. November, 1932. p. 713.
Control of pump motors in an office building; heating-system vacuum pumps; boiler-feed pump; sump pumps; 40-hp. motors have starters of compensator type; controls for synchronous motors; manual switches for circulating pumps; control of the fire-pump motor; points to observe in connection with motor protective devices. 4 i.

What the Hartford Loop Is and What It Does, by Robert E. Hattis.
No. 7. July, 1932. p. 483.
What the loop is; what it does; how it prevents low water in boiler; its use with boilers in parallel; typical installations on cast-iron and steel boilers. 9 i.

Rolling, Turning of Pipe Being Welded; How It's Prevented, by William L. Hand.
No. 8. August, 1932. p. 541.
New Field office building, Chicago, an all-welded job; causes of rolling and turning; how contractor prevented it; welding procedure; piping must keep pace with building; ¾-in. connections welded; caring for expansion; radiator branches and connections of copper. 1 i.

Stops Scale From Clogging Radiator, by W. H. Wilson.
No. 8. August, 1932. p. 552.
(On the Job); radiator return connections which aid in cleaning out scale or prevent stoppage. 1 i.

How to Paint Hot Surfaces, by Herbert Chase.
No. 8. August, 1932. p. 553.
(On the Job); cleaning galvanized surfaces; primer promotes adhesion; effect of paint on heat emission.

Heating—Warm Air and Electric

Utilizing Waste Gases for Factory Heating, by H. C. Weller.
No. 7. July, 1932. p. 474.
Gem Clay Forming Co., Sebring, Ohio, uses waste gases from continuous pottery kiln for factory heating and drying; saving in heating cost is $7,500 annually; kiln fired with natural gas; gas consumption; principles involved; determining available heat in flue gases; comfort and health in plants heated with waste gases; duct system; loss of head in ducts. 6 i.

Selecting Direct-Fired Gas Heaters, by Platte Overton.
No. 3. March, 1932. p. 176.
Gas unit (fired with natural gas) heats factory offices; data sheet and floor plans; inlet temperature and air supplied; provisions for cooling with tap water; method of selecting the capacity of the heater; determining inlet temperature; sizing ducts to resistance (table); gas units heat factory space. 2 i.

Heats School With Two Oil-Fired Furnaces, by John Howatt.
No. 11. November, 1932. p. 724.
Warm-air heating plant in 8-room Bret Harte school, Chicago; calculating heating load; the furnaces; reducing heat loss through ceiling; humidification; temperature regulation; stratification in ducts; test run; results; fuel oil consumption; zoning control. 4 i.

Heating a Garage Economically, by Samuel R. Lewis.
No. 1. January, 1932. p. 20.
Method of heating a two-car apartment-house garage; duct from boiler room; unit heater; heat transfer device below boiler water-line; introducing air for combustion to a boiler room. 3 i.

Auxiliary Electric Heating With Off-Peak Power a Method of Cutting Cost, by Lee P. Hynes.
No. 10. October, 1932. p. 658.
Off-peak power at low rates used for auxiliary space heating in plants and buildings; opportunities; methods; supplying hot process water; economics of proposition; typical applications. 6 i.

Piping—General

Leak-Tight Joints—600 to 550,000 Lb., by F. E. Wertheim.
No. 7. July, 1932. p. 469.
Types of high-pressure pipe joints which have successfully met service requirements; air-tight joints for 2,000-lb.; water-tight joints under 1,750-ft. head; gas-tight joints at 800 lb. (couplings; split-housing flexible joints); steam-tight joints—600-lb. W. S. P. to 3,300-lb. (Loeffler joint; weld-seal joint; Benson joint); standards for 1,500-lb. W. S. P. weld-seal joints; spherical-seat joints.

Leak-Tight Joints—600 to 550,000 Lb., by F. E. Wertheim.
No. 8. August, 1932. p. 546.
A. S. A. tongue-and-groove joints; ring joints; wedge-ring joint; Dr. Percy W. Bridgman's leak-tight joint at 550,000 lb. per sq. in.; "unsupported area" principle; union for small-size high-pressure tubing; joint for large diameter apparatus; conclusions; bibliography. 10 i.

Flow Meters, by Louis Gess.
No. 12. December, 1932. p. 792.
Use of flow meters increasing; avoid expensive changes in piping to permit accurate metering; fittings affect accuracy; straightening vanes; measuring discharge from boilers; location of manometer; measuring flow of steam and liquids; measuring flow of gas; measuring pulsating flow. 4 i.

Using Pipes As Beams, by M. Barry Watson.
No. 10. October, 1932. *p.* 667.
(On the Job): chart simplifies picking proper size of pipe for use as beam for supporting tanks, etc.; use bearing surface to apply load; using chart to solve typical problem; getting a boiler across a gap on pipe supports. 2 i.

Using Pipe for Columns, by M. Barry Watson.
No. 12. December, 1932. *p.* 806.
(On the Job); chart enables selection of right size pipe for use as compression members in supporting tanks, heaters, etc.; how chart is used. 1 i.

Apply Pipe Wrench Properly, by John J. Harman.
No. 9. September, 1932. *p.* 618.
(On the Job); proper application of wrench prevents damage to pipe; direction and magnitude of forces; high crushing position should be avoided; application of wrench to alloy cast-iron pipe; don't use over-size wrench; schedule of proper sizes. 2 i.

Several Piping Tools I've Found Handy, by W. H. Wilson.
No. 12. December, 1932. *p.* 808.
(On the Job); several wrenches of particular value in piping maintenance and installation; screw jack; pinch bar; wedge; scraper. 1 i.

Don't Forget Safety in Piping!, by W. H. Wilson.
No. 9. September, 1932. *p.* 621.
(On the Job); safety is important in industrial piping; compressed air used for removing heavy hydraulic ram; water pressure safer; other unsafe practices and remedies; provide tapped opening in steam valve body to relieve pressure. 2 i.

Properly-Located Shut-Off Valves Aid Maintenance, by W. H. Wilson.
No. 1. January, 1932. *p.* 86.
(Practical Piping Problems); need for proper shut-off valves; location depends on conditions; fire-protection piping changed; shut-off valve in steam header; pump suction line; drain tappings on gate valves. 7 i.

Center-to-Face Dimensions for Ferrous Flanged Valves.
No. 3. March, 1932. *p.* 179.
Center-to-face dimensions for ferrous flanged valves approved by *Manufacturers' Standardization Society of the Valve and Fittings Industry;* tentative proposal being distributed for criticism.

Organizing for Industrial Piping Installations.
No. 5. May, 1932. *p.* 396.
(On the Job); modern production methods applied to installing industrial welded piping; chart shows flow of authority and of materials; bill of materials; line list; method simplifies cost keeping. 2 i.

Portable Hoists Aid Installation, by L. B. Murdock.
No. 11. November, 1932. *p.* 742.
(On the Job); use of portable lifters in the installation and maintenance of piping, heating and air conditioning equipment; types used. 3 i.

Templet Aids in Detailing Piping, by Clinton C. Hubbell.
No. 2. February, 1932. *p.* 97.
Construction and use of a templet which facilitates drawing piping lay-outs. 2 i.

Pipe Support Fabricated by Welding.
No. 11. November, 1932. *p.* 745.
(On the Job); detail of pipe support made from channels by welding. 1 i.

Paints Indicate Approximate Temperature, by Herbert Chase.
No. 1. January, 1932. *p.* 86.
Use of heat sensitive paints in experimental or routine testing; composition of a paint for temperatures up to 300 F; color and temperature range; other temperature-sensitive paints.

Heat Sensitive Paint, by S. W. Rushmore.
No. 2. February, 1932. *p.* 122.
Uses for heat sensitive paints.

Piping—Air

Solving Vacuum Pump Problems, by S. B. Redfield.
No. 1. January, 1932. *p.* 24.
Selecting a vacuum pump for a system which handles sheets of paper by vacuum; test run; approximate volumetric efficiency line; effect of vacuum on amount of air flowing; formulas for flow, according to Fleigner; pump displacement; equivalent area method; flow of air through nozzles; "flow ratio"; determining air leakage into a system. 4 i.

Design and Installation of Piping for High Vacuum Pneumatic Conveyor Systems, by E. H. deConingh.
No. 1. January, 1932. *p.* 17.
Use of pneumatic conveying; joining piping; wear-resisting bends; fittings; conveying capacity; lay-out of piping. 7 i.

Piping Air for Pipe Organs Presents Interesting Problems, by Lester C. Smith.
No. 11. November, 1932. *p.* 751.
Installation described; organ blower requirements; conveying wind to organ chest; electrical control of blowers. 4 i.

Removing Moisture from Air Piping, by C. A. Dawley.
No. 3. March, 1932. *p.* 248.
("Open for Discussion"); removing moisture from underground air lines; diagram shows lay-out. 1 i.

Piping—Oil

Piping Steam for Heating Oil Tanks, by Samuel R. Lewis.
No. 9. September, 1932. *p.* 610.
Need for and advantages from heating oil tanks in plants and oil-handling stations; joints may be steam-tight, but leak oil; oil must not enter boiler; steam should be controlled; arrangement for skimming oil from water; variety of methods for heating tanks shown by investigation; several typical arrangements commented on and shown; oil as heat-carrying medium; steam pressures used; volume of "1,000 gal. of oil at 60 F" at various temperatures. 8 i.

Unloading Oil from Tank Cars, by W. H. Wilson.
No. 2. February, 1932. *p.* 169.
(Practical Piping Problems); unloading an oil car with a defective valve; a steam heater for an oil car unloading nozzle. 2 i.

Use of the Proper Piping Material Important, by W. H. Wilson.
No. 6. June, 1932. *p.* 462.
(On the Job); illustrations of three valve discs removed from fuel-oil line show need for using the proper material. 1 i.

Water Seal Protects Valve Diaphragm, by W. H. Wilson.
No. 11. November, 1932. *p.* 743.
(On the Job); water seal protects composition steam valve diaphragm which is controlled by fuel-oil pressure; installation and layout; injurious effect of oil on diaphragms. 2 i.

Piping—Process Liquids

Problems in Piping Chemicals Typified by Acetic Acid, by D. F. Othmer.
No. 5. May, 1932. *p.* 346.
Methods of acetic acid production; use is wide; piping material must be carefully chosen; acetic acid inflammable when anhydrous; use of wooden pipe; rubber hose and pipe has applications; metallic piping materials (copper, silver, high-silicon cast iron, stainless steels, lead, aluminum, tantalum); electroplating tantalum. 4 i.

Acid Piping System Saves Handling Costs, by Dwight Spofford.
No. 2. February, 1932. *p.* 110.
Piping layout for handling sulphuric and hydrochloric acid at plant of Electro-Chemical Engraving Co., New York City; pipe tunnel; storage tanks; pumps; operation. 2 i.

Choose Motor to Meet Conditions, by Francis A. Westbrook.
No. 11. November, 1932. *p.* 740.
Totally-enclosed fan-cooled motor first drives fan handling acid fumes, then shifted to electrolytic pump; service constant; "breathing"; pick motor to meet local conditions. 1 i.

Piping—Refrigeration

Piping Problems of the Bakery—Refrigeration Piping, by Arthur W. Archer.
No. 6. June, 1932. *p.* 407.
Bakeries largely mechanized; a typical plant; uses of refrigeration in bakery; direct-expansion system; brine for severe climates; refrigeration equipment; pipe shaft; provisions for cleaning; mixing room cooling and heating; baudelot tank in storage room; yeast storage box; cooling tank construction; tank for mixer jacket water; cold air for mixer bowls; cooling tower; pipe and fittings; insulation; allowing for expansion; air bunker; piping details. 6 i.

Refrigerating System Cools Air and Water, Condenses Alcohol, Freezes Waxes, Makes Ice, Etc., by Terry Mitchell.
No. 3. March, 1932. *p.* 184.
Description of refrigerating and air conditioning equipment in Philadelphia plant of Sharp & Dohme, manufacturers of pharmaceutical and biological products; requirements of the various services; piping layout and methods of meeting them. 5 i.

Piping Layout for an Ice-Skating Rink, by E. Zuckerman.
No. 2. February, 1932. *p.* 113.
Indoor ice-skating rink at University of Illinois; refrigerating equipment; piping arrangement; details of header piping and slab construction; piping welded; slab is expansion floating type; provisions made for installing a brine heater. 4 i.

Changes Pipe Size, Nets 31 Per Cent on Cost, by Herman Vetter.
No. 11. November, 1932. *p.* 731.
Correctly-sized suction line on ammonia compressor cuts power charge; calculating volume of vapor handled; determining hp required; example shows possible saving; pressure drop in piping; vapor velocities in suction piping. 2 i.

Plants Pay for Proper Piping, Whether They Have It or Not, by R. C. Doremus.
No. 11. November, 1932. *p.* 733.
Proper piping design in refrigerating plants of economic importance; if lines are too small, power cost is high.

Check Refrigerating Coils, by Robert S. Wheaton.
No. 7. July, 1932. *p.* 490.
(On the Job); knowledge of ammonia properties essential in design of ammonia coils for cooling brine; rule-of-thumb methods dangerous; coils for a typical brine tank; types of coils for brine or ice-making tanks. 1 i.

Piping—Steam (Including Steam for Process)

Plant and Utility Exchange Steam and Power—$70,000 Saving Estimated, by William A. Hanley.
No. 5. May, 1932. *p.* 331.
Eli Lilly and Company, Indianapolis, Ind., supplied high-pressure steam through underground line by Indianapolis Power & Light Co.; steam and electric requirements; four plans studied; the plan adopted; reliability of electric supply; features of contract; investment and operating costs of plans for supplying process steam; typical process steam and electric requirements. 4 i.

Plant and Utility Exchange Process Steam and Power, by William A. Hanley.
No. 6. June, 1932. *p.* 421.
(Continued from May, 1932, issue); provision for any change from coal fuel; old boilers in plant; metering; $50,000 steam per year guaranteed; coal cost arbitration; contract effective; rate for steam; payments; billing demand; billing month; coal clause. 2 i.

Process-Steam Plants Need Carefully-Designed Piping, by E. C. Gaston.
No. 12. December, 1932. *p.* 779.
Steam requirements vary widely; paper mill a typical example; points influencing piping layout; design of the piping; heat available for power depends on pressure drop in piping; choosing economical size; expansion; guides, anchors, supports; drainage; reducing steam to two or more pressures; desuperheating. 4 i.

Process Steam Reduced Through Turbines Saves in Cost of Power, by Francis A. Westbrook.
No. 3. March, 1932. *p.* 193.
Large quantities of low-pressure steam used for process in plant of Crofut & Knapp Co. (hat makers), South Norwalk, Conn.; 165-lb. steam reduced through turbines; electric power is by-product; process steam heats water; piping layout; cost of steam; 75 per cent make-up. 3 i.

Piping a Blow-Down Which Saves $11.64 Daily, by Clyde R. Hoey, Jr.
No. 6. June, 1932. *p.* 416.
The system used; location of collectors; two regulating valves

for each boiler; flashed steam to feedwater heater; flow meter aids valve setting; calculation of heat saving made. 2 i.

Erecting a High-Pressure, High-Temperature Steam Line, by H. C. Schramm.
No. 9. September, 1932. *p.* 598.
14-in. line for 600-lb, 720 F steam at West Virginia Pulp and Paper Co. plant, Piedmont, W. Va.; arc welding with shielded electrodes; instructions for welding; removing mill scale; chill bands aid welding; clamp for aligning pipe; assembling the flanged joints; steel gasket welded between flanges; putting the piping in place; testing the line; putting line in service. 9 i.

Selection of Pipe Bends Simplified, by W. G. Hooper.
No. 9. October, 1932. *p.* 653.
Higher steam pressures and temperatures makes provisions for piping expansion of increased importance; flattening of the cross-section; formulas for quarter-, U-, expansion U-, and double offset expansion U-bends; assumptions; comparison with other formulas; curves and data presented simplify bend selection; cold springing; solution of typical problem; dimensions and moment of inertia of standard, extra-strong; 400-lb ASA seamless; 600-lb ASA seamless, 900-lb ASA seamless and 1500-lb ASA seamless pipe; expansion of steel pipe; recommended values for modulus of elasticity. 7 i.

Calculation of Friction Loss in a Multiple Loop Header System, by Max W. Benjamin.
No. 2. February, 1932. *p.* 91.
Factors which influence layout; main steam piping at Delray power plant illustrates problem; pressure loss through fittings; calculation of pressure loss; Fritzsche's formula; equivalent resistance of fittings, Foster's formula; drop in tee between boiler leads and header; pressure drop in pipe lines. 5 i.

Chart for Pressure Drop in Low-Pressure Steam Piping, by Julius Hulman.
No. 5. May, 1932. *p.* 343.
Chart simplifies use of formula; method; typical problems solved; correction factors for high pressures; example of use. 1 i.

Testing High-Pressure Steam Piping, by John J. Harman.
No. 4. April, 1932. *p.* 253.
Necessity for care in layout; standards for flanged joints; American standard joints, bolts and bolting material, threads, nuts, finish of flange faces; bolts for flanged joints; computing stress in flange bolts; turning moment to produce bolt stress and formula; chart for initial bolt stresses and relation between turning moments and bolt stresses; gaskets; assembly and testing of joints; order for tightening 16-bolt flange; field testing; test pressure must be in proportion to working pressure; hydrostatic test procedure; drying out of valve packing; testing will become standardized. 6 i.

Method and Charts for Determining Economical Thickness of Insulation, by Temple C. Patton.
No. 1. January, 1932. *p.* 6.
Three type cases considered; one insulation material applied to a flat surface; two insulation materials applied to a flat surface; one insulation material applied to circular piping; typical examples show use of charts; detailed development of the method; scope; summary of formulas. 5 i.

Formulas for Economical Thickness of Insulation Corrected, by Temple C. Patton.
No. 3. March, 1932. *p.* 248.
Typographical errors in "Method and Charts for Determining Economical Thickness of Insulation" (January, 1932, issue) corrected by author.

Note on the Insulation of Piping, by A. F. Dufton.
No. 5. May, 1932. *p.* 355.
(Open for Discussion); two charts facilitate method of choosing proper thickness of insulation described by Temple C. Patton in January, 1932, issue. 2 i.

Asbestos Cloth Products Insulation on Piping Near Boilers, by William J. Deckman.
No. 3. March, 1932. *p.* 201.
Use of asbestos cloth blankets for protecting insulation on water wall circulating tubes at Deepwater power plant; how the blankets are made and installed. 1 i.

Limited Space, Water-Logging Complicate Steam-Coil Installation, by G. W. Hauck.
No. 11. November, 1932. *p.* 717.
Steam coil in process tank in chemical plant; assembly; three coils staggered to increase heating effectiveness; details of inlets and outlets; trapping. 4 i.

Utilizing Heat of Condensate in Pipe Coils, by W. H. Wilson.
No. 4. April, 1932. *p.* 326.
(Practical Piping Problems); method of arranging pipe coils for utilizing heat in the condensate for space heating; need of care in draining pipe coils illustrated by an example. 2 i.

Solving a Temperature Control Problem, by E. D. Rogers.
No. 7. July, 1932. *p.* 472.
Instantaneous water heater in plant draws steam from turbine; vacuum in heater caused heavy load to be thrown on turbine; bypass around temperature regulator kills vacuum. 1 i.

Steam from Seed Cooker Heats Water, by J. Gordon Fletcher.
No. 11. November, 1932. *p.* 744.
(On the Job); steam used in four linseed cookers used for heating washroom water in plant; indirect water heater used; layout. 1 i.

Trapping Saves Fuel, by T. H. Rea.
No. 1. January, 1932. *p.* 30.
Closed gravity return systems; use of separating traps; trapping saves fuel for a greenhouse; possible arrangements of traps with such systems. 5 i.

Operating Industrial Steam Piping, by W. H. Wilson.
No. 3. March, 1932. *p.* 249.
(Practical Piping Problems); proper operation reduces maintenance work; turning steam on fast eliminated water hammer in one line; changing from exhaust to high pressure steam caused trouble in another system; reservoir in steam main cares for condensation. 3 i.

Operating Steam Mains, by W. H. Wilson.
No. 5. May, 1932. *p.* 395.
(On the Job); factors which influence successful operation of steam piping; operating troubles and how they were corrected; steam supply failed to maintain required pressure; fitting broken by water of condensation; 1 i.

Change in Steam-Main Drain Prevents Trouble, by W. H. Wilson.
No. 8. August, 1932. *p.* 552.
(On the Job); water hammer occurred in steam main; drainage connection changed to remedy difficulty; draining steam mains. 2 i.

Stopping Vibration of a Steam Line, by Bernard Kramer.
No. 12. December, 1932. *p.* 807.
(On the Job); steam line to reciprocating engine vibrated; how layout was changed to stop trouble; water-leg for moisture separation. 1 i.

Installing Globe and Angle Valves, by W. H. Wilson.
No. 6. June, 1932. *p.* 459.
(On the Job); opinions differ as regards position of valve disc in relation to direction of steam flow; several experiences which indicate proper method. 4 i.

Industrial Heat and Power.
No. 1. January, 1932. *p.* 39.
Communication from Wm. F. Ryan regarding the use of steam for process and power in industrial plants; should be regarded as a single problem; multiple effect evaporation may cut steam consumption.

Modernize Heating, Piping and Air Conditioning Systems for Efficiency and Economy—Steam Piping.
No. 10. October, 1932. *p.* 661.
Check-list aids in spotting steam waste; maintenance guide for steam-piping systems. See p. 741, November, 1932, for one engineer's use of this check-chart and guide.

Piping—Water and Hydraulic

Combating Corrosion of Piping, by C. E. Joos and V. A. Rohlin.
No. 8. August, 1932. *p.* 533.
Methods of stopping pipe corrosion; necessity; causes; what "pH" means; indication of a water's corrosive tendencies; controlling effect of pH explained; reducing available ionic hydrogen reduces corrosion rate; rate of displacement of hydrogen by iron from various waters; oxygen in solution; electrolytic corrosion; characteristics of water supplies; effect of temperature. 6 i.

Combating Corrosion of Piping, by C. E. Joos and V. A. Rohlin.
No. 9. September, 1932. *p.* 606.
How deaeration protects piping; types of deaerators (direct contact, flash, evaporator or surface). 1 i.

Combating Corrosion of Piping in Plants and Buildings, by C. E. Joos and V. A. Rohlin.
No. 10. October, 1932. *p.* 670.
Methods of installing deaerating heaters; supplying mains by gravity; when hot-water demand fluctuates; deaerator in basement; deaerator and storage tank in basement; deaeration of condensate returns; protecting piping in central-heating plants; protection of industrial piping. 7 i.

Saving Money in Heating Water for Use in Buildings, by L. K. Ferris.
No. 11. November, 1932. *p.* 721.
Consumption of domestic hot water; sources of heat; heat required for return water important; reducing circulating losses; data on one building show need for a study; heat supplied to water from various sources in an office building. 3 i.

Controlling a Water Heater, by E. D. Rogers.
No. 5. May, 1932. *p.* 396.
(On the Job); improper application of temperature control may give unsafe conditions; water in heater reached too high a temperature; piping layout revised. 1 i.

Cutting the Cost of Extras, by E. C. Parker.
No. 9. September, 1932. *p.* 617.
(On the Job); change made with job 80 per cent completed; water at 70 F (2 degrees plus or minus) needed for photographic room; water for air-conditioning system cools house service water in interchanger to 65 F; thermostatic mixing valve supplies 70-F water by mixing 65 F and 83 F house service; piping diagram. 1 i.

Care Needed in Valve Operation, by W. H. Wilson.
No. 7. July, 1932. *p.* 490.
(On the Job); care needed in operation; valve stem broken when valve was obstructed; how to open a stuck valve; locating trouble in water lines. 1 i.

The Sight Flow in Piping Systems, by F. E. W.
No. 6. June, 1932. *p.* 461.
(On the Job); uses of sight flow funnels; a cast aluminum funnel; a cast funnel, bronze or aluminum. 2 i.

A Simple and Practical Tank Overflow.
No. 1. January, 1932. *p.* 86.
Tank overflow arrangement giving full area of overflow pipe while functioning satisfactorily as a strainer. 1 i.

Loss in Elbows and Bends, by F. E. Giesecke.
No. 2. February, 1932. *p.* 122.
("Open for Discussion"—comments by F. E. Giesecke on "Piping Improvements Reduce Cost of Pumping" in October, 1931, issue); loss of head in elbows and bends in water piping.

Preventing Drip from Pipes, by Herbert Chase.
No. 4. April, 1932. *p.* 327.
Painting black pipe; use of granulated cork to help prevent condensation on pipes; cleaning galvanized surfaces.

Insulation of Cold-Water Lines, by T. E. Willson, Jr.
No. 6. June, 1932. *p.* 424.
Comments on "Preventing Drip from Pipes," April, 1932, issue; rule-of-thumb method for thickness will not suffice; use of molded pipe covering; author comments.

Gaskets and Packing for Hydraulic Power, by F. E. Wertheim.
No. 3. March, 1932. *p.* 202.
Advantages of hydraulic power; packing piston for hydraulic cylinder; pipe joints; red fiber; designing a copper gasket; method; soft iron gaskets; piping should be constrained to avoid whip. 4 i.

Equipment Developments

No. 4. April, 1932. *p.* 328.
Railway Air Conditioning Units; Electrodes for Welding Aluminum; High Capacity Steam Traps; Boiler Water Level Recorder; Drip Traps of Compact Design.

No. 5. May, 1932. *p.* 398.
A Circuit Breaker; Compound Dehumidified air; Combustion

Indicator-Recorder; Anti-Balancing Device for Traps; Protecting Galvanized Surfaces; Control for Hot-Water Supply.

No. 6. June, 1932. p. 462.

Control for Steam-Heating Systems; Valve for 125-Lb. Steam, 175-Lb. Water; New Low-Return Pump; Control for Unit Ventilators; Rotary Compressors for Air Conditioning; New Line of Water Meters; A Low-Voltage Thermostat; Cooling and Heating Units.

No. 7. July, 1932. p. 526.

A Plug-Type Valve; Fans for Fumes; New Conversion Units; Small Steam Traps; Room Cooler of Interest; For Pumping the Sump; Removes Oil from Steam; Solder for Aluminum; For Cooling Rooms; Potentiometer Is Self-Balancing; Controls Air Temperature; This Valve Is Cleanable; Capacitor-Type Motors; Cools and Dehumidifies; Handles Chemicals, Foodstuffs; Valve for 125-Lb Steam; Pneumatic Switch Is Compact; Air Infiltration Thermostat; For the Dry-Kiln Operator.

No. 8. August, 1932. p. 587.

Friction in Regulator Minimized; Bucket Trap Action Improved; Keeps Out Noise, Conditions Air; Three Motors Developed; Controls Injection of Chemicals; A Blowpipe; An Extensometer; Filter Employs Felt Glove; Cools Railway Cars; Heating Field Uses Molded Knobs; V-Groove Steel Pulleys; For Pressure Relief; Tapered Spindle in Trap; To Filter Air.

No. 9. September, 1932. p. 622.

Two-Ply Steel Announced; Pump Is Self-Priming; Valves Control Temperature; Gasket Resists Oil; Valves for Close Control; Die-Head Is Automatic; Flow Meter for Many Uses; Easy-to-Install Superheater; Bonnet Assembly for Radiators; A Ball-Swivel Pipe Hanger; Heater for Oil Tanks; Air and Control Valve; Valve Disc Rotates; New Supervisory Control; Supply Process Steam; Units Are Gas-Fired; Controls Liquid Temperature; Hot-Water Relief Valve; Feeder Easy to Install; Fans Have Safety Guards; Conceals Screw Heads; Regulates Furnace Draft; A Built-in Fin-Type Heater; Exhauster of Stoneware; Switches Have Thermal Overload Relays.

No. 10. October, 1932. p. 682.

New Mechanical Flow Meters; New Finned Pipe; Pump Handles Large Volumes; For Checking Temperatures; Isolates Vibration; Industrial Switch Line Completed; Registers Control Air Flow; Announces New Welding Rods; Control Has Commutator-Type Contacts; Indicating-Type Flow Meter; Line-Starters Are Explosion Resisting; New Vacuum Valve; Controls Humidity.

No. 11. November, 1932. p. 746.

Pumps Handle Chemical Solutions; New Method of Packing Expansion Joint; Fin-Type Convectors of Cast Iron; New Fluid Meters Announced; High-Water Alarm for Tanks; Equalizes Hot-Water Systems; Underfeed Stoker of Ram-Type; Railway-Car Precooler Announced; Turbine Drives Fans, Pumps; New Unit Cools or Heats; Tests Show Performance of Vacuum Pump; New Motor-Pump Unit; Sensitive Thermo-Regulator; Dry-Type Filters Have Many Uses; Press-Brake of Welded Construction.

No. 12. December, 1932. p. 801.

Vapor-Turbine-Driven Heating Pump; Cools Water with Steam; New Valves for Temperature Control; Cleans Heating Boilers; Generates Process Steam; For Accurate Humidity Control; Humidifier Nozzle Cleans Self; Compensator Features Oil-Relief Valve; New Trailer-Type Welder; Motor Is Splash Proof; Float Traps for Risers, Small Mains; New Pumping Units; Solenoid Water Valves Saves Current; Welder Has Dual Control.

Book Reviews

Publishes Book on Calculating Heat Transmission.
No. 9. September, 1932. p. 622.
Review of "The Calculation of Heat Transmission" by Margaret Fishenden and Owen A. Saunders; contents.

District Heating Book Issued.
No. 8. August, 1932. p. 556.
Contents of "Handbook of the *National District Heating Association.*"

Methods for Sampling Steam and Condensate in Corrosion Studies.
No. 7. July, 1932. p. 486.
Causes of pipe corrosion; booklet on sampling steam and condensate for corrosion studies published by *National District Heating Association* committee.

A Half-Century of District Steam Service Described.
No. 7. July, 1932. p. 486.
New York Steam Corp. publishes book commemorating fiftieth anniversary.

Bridgman's Book on High Pressure Reviewed, by F. E. Wertheim.
No. 4. April, 1932. p. 274.
Review of "The Physics of High Pressure," by P. W. Bridgman; scope and contents.

Effect of Temperature on Metals Subject of Symposium.
No. 4. April, 1932. p. 260.
"Symposium on Effect of Temperature on Metals" published by *A. S. M. E.* and *A. S. T. M.*: purpose and scope.

Symposium on Welding Published.
No. 3. March, 1932. p. 179.
American Society for Testing Materials publishes "Symposium on Welding"; papers included.

Text on Refrigeration Published.
No. 9. September, 1932. p. 620.
Contents of third edition "Principles of Refrigeration" by W. H. Motz; adopted for study by *National Association of Practical Refrigerating Engineers.*

"Refrigerating Data Book" Published.
No. 7. July, 1932. p. 492.
Contents and price of refrigerating data book published by *American Society of Refrigerating Engineers.*

New German Book on Drying.
No. 11. November, 1932. p. 737.
"Die Trockentechnik" reviewed by Malcolm Tomlinson.

Bulletin on Air Flow Through Orifices.
No. 7. July, 1932. p. 477.
Investigation to verify and extend range of existing data on air flow through square-edged circular orifices in thin plates at *University of Illinois*; bulletin gives results.

A. S. T. M. Proceedings Published.
No. 2. February, 1932. p. 99.
Review of Proceedings of *American Society for Testing Materials*, 1931.

English-German-French Dictionaries Published.
No. 5. May, 1932. p. 345.
Hoyer-Kreuter Technical Dictionary.

Handbook on Gas Heating Issued.
No. 5. May, 1932. p. 345.
New Jersey Gas Association issues handbook.

Tests of Joints in Plates Reported.
No. 5. May, 1932. p. 345.
Several types of joints in wide plates used in construction of tanks for water and oil storage tested; results reported in *University of Illinois* bulletin.

New Book on Industrial Temperature and Humidity Control.
No. 12. December, 1932. p. 796.
Contents of "The Handbook of Industrial Temperature and Humidity Control," by M. F. Behar.

Industrial Management Described.
No. 12. December, 1932. p. 797.
Review of "Industrial Management in this Machine Age," by Francis A. Westbrook.

Text on Automatic Refrigeration Control.
No. 12. December, 1932. p. 797.
Review and contents of "The Automatic Control of Refrigeration," by H. T. Lange and A. B. Schellenberg.

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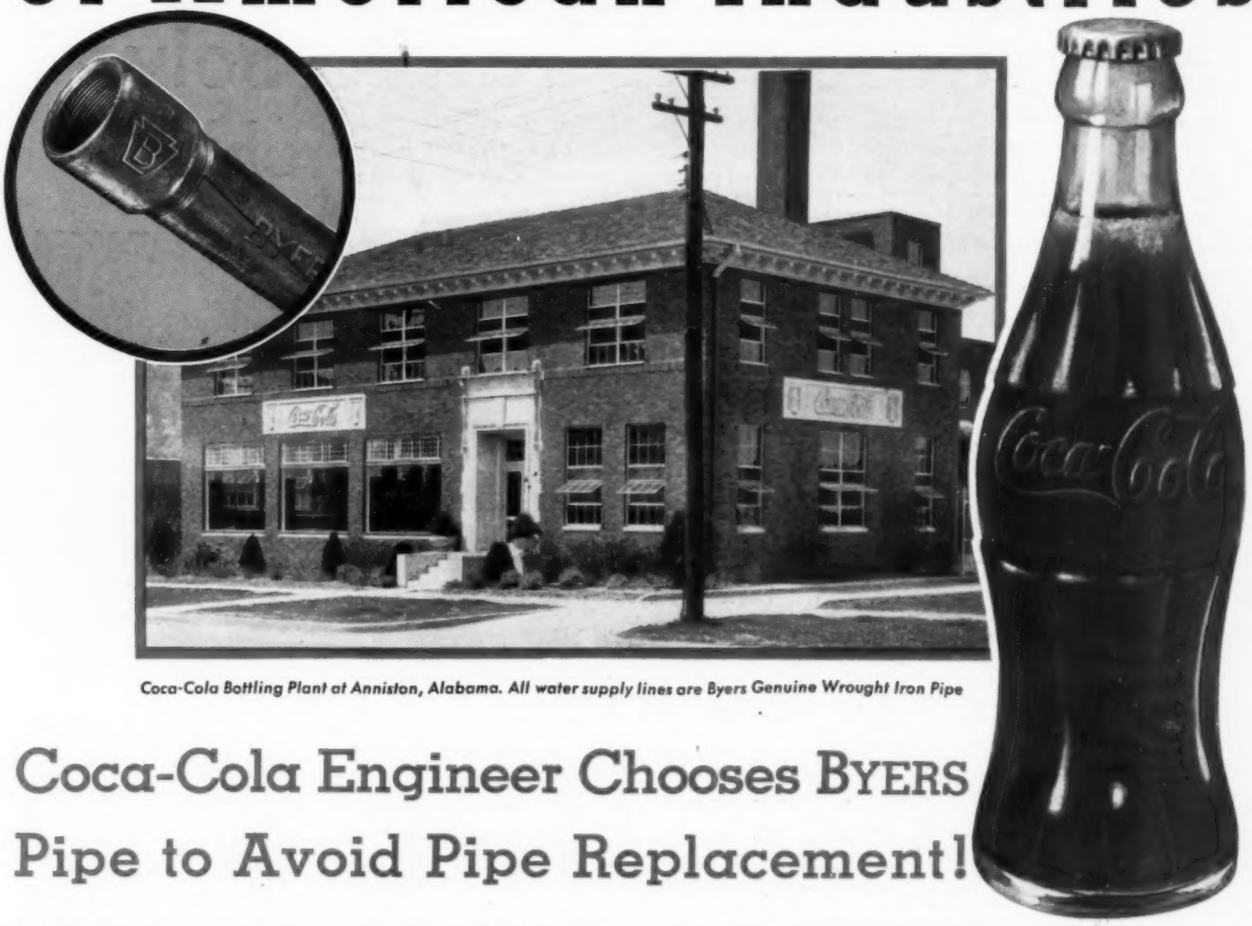

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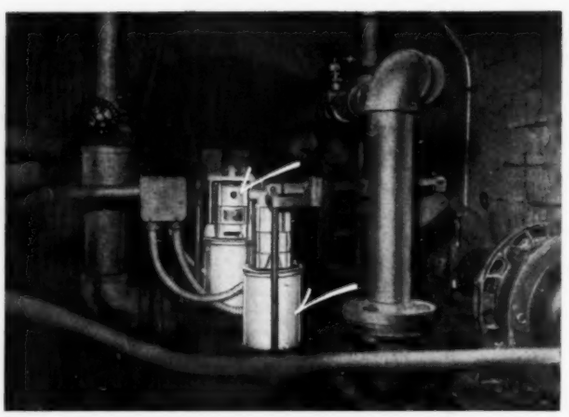

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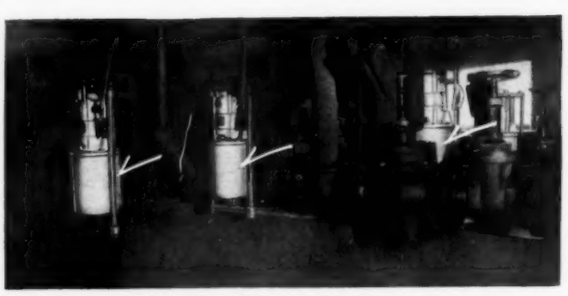

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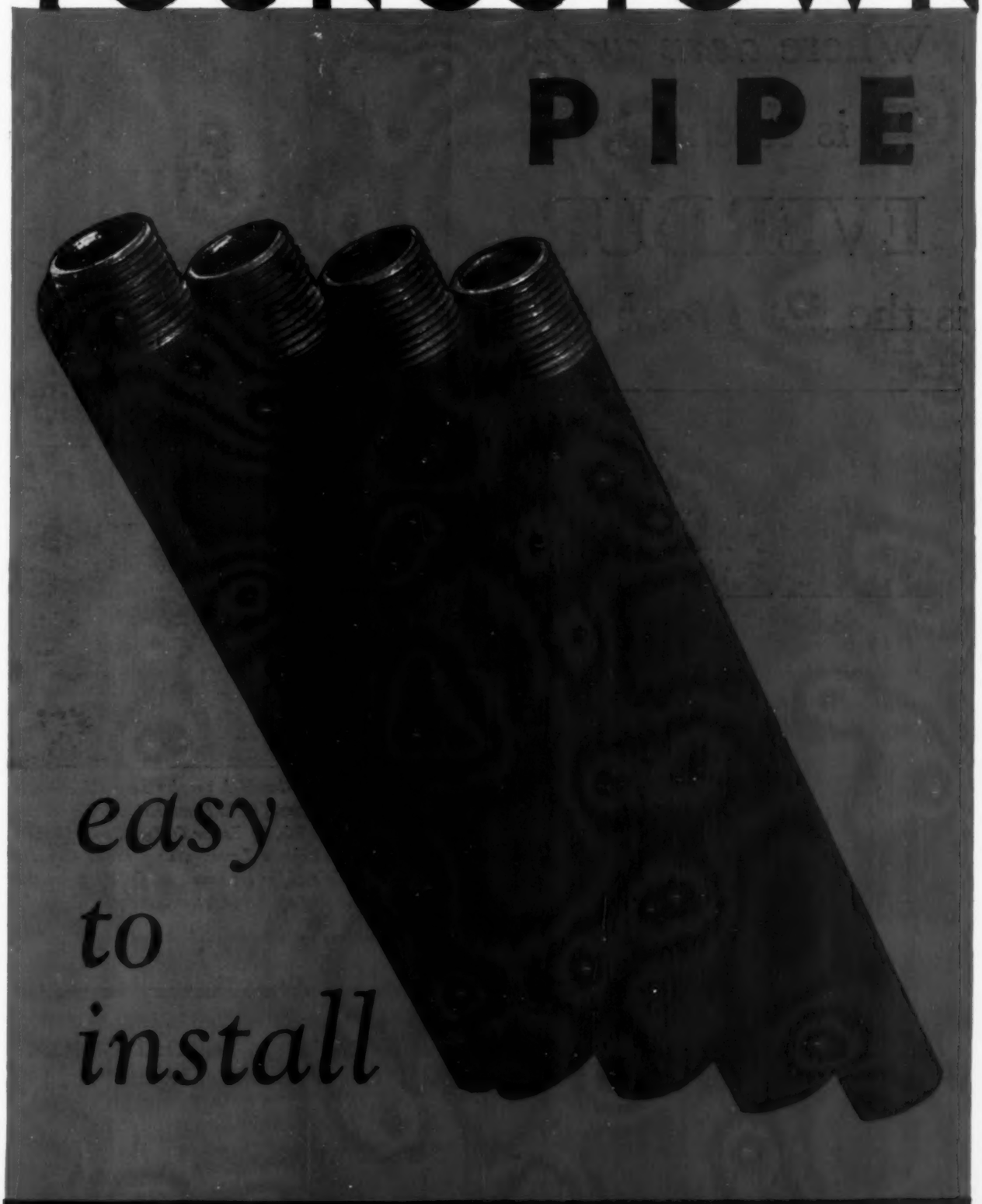

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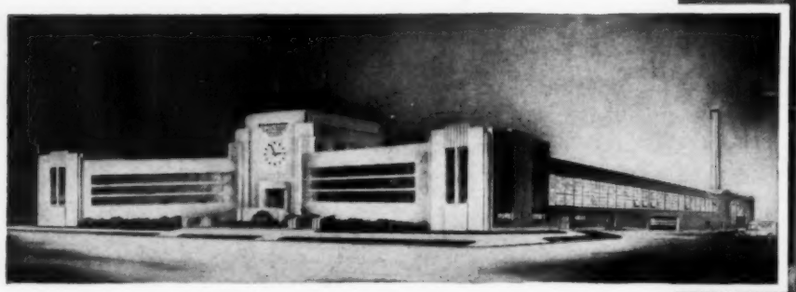

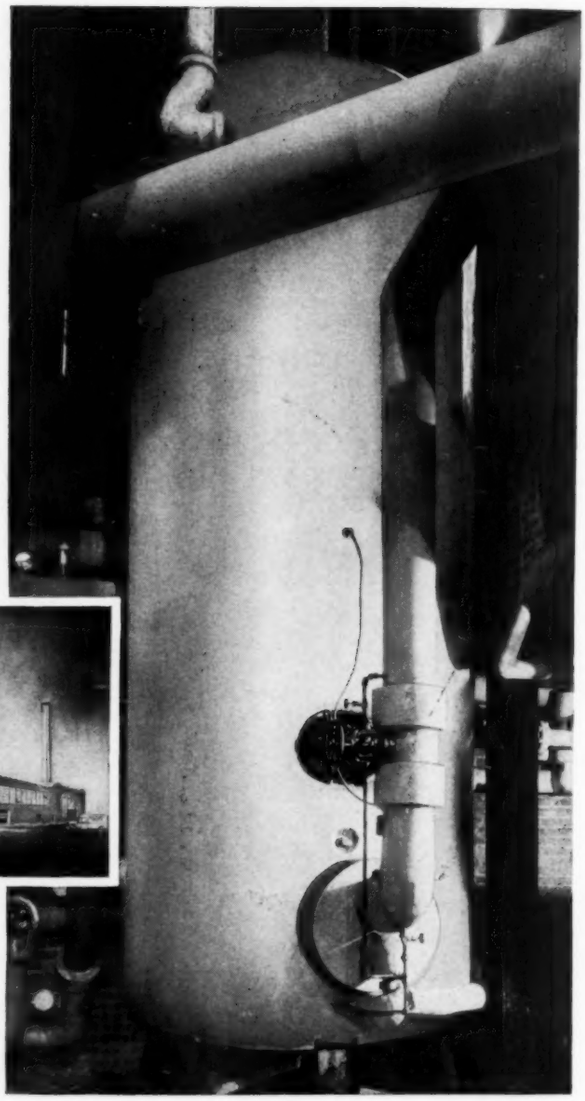

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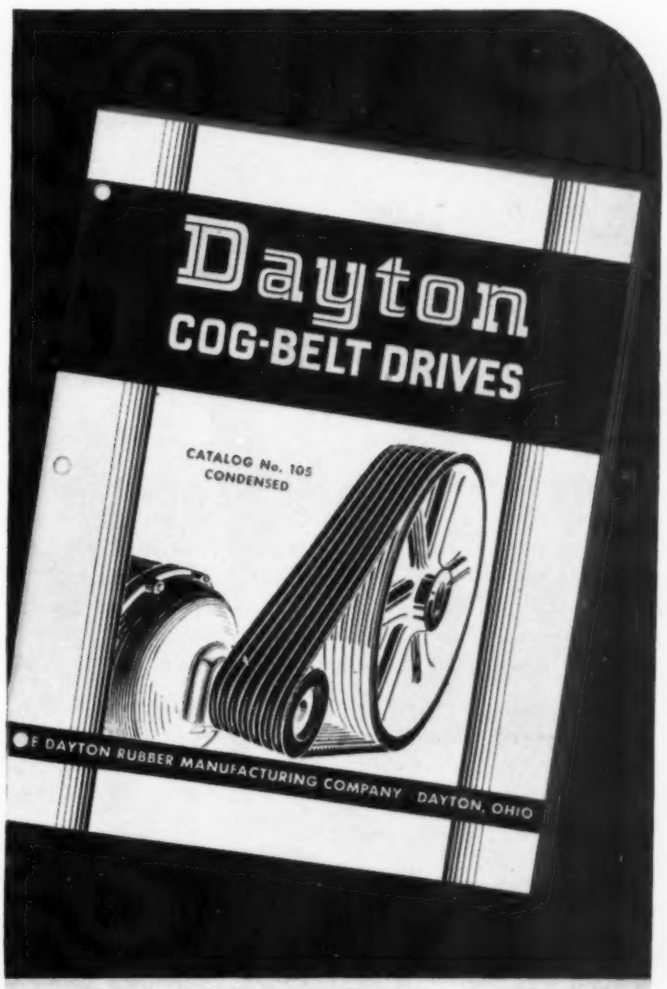

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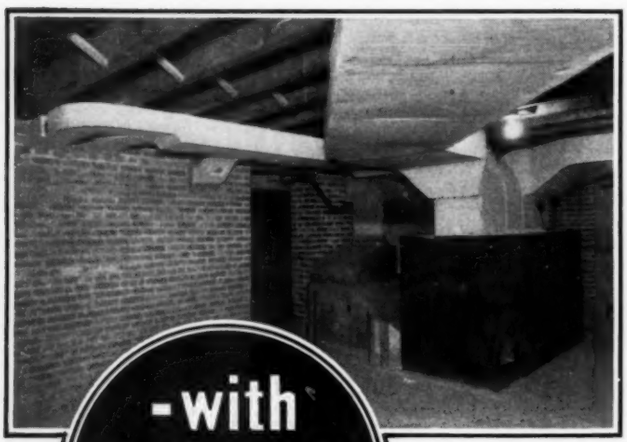

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Here is the mechanical heart of one of the "Twin-Residence" heating and ventilating systems. Note the neat, compact layout and the flat-style Ingot Iron main and branch ducts, sheathed with 3-ply air-cell insulation, to which is cemented 8-ounce canvas, painted white.

These two Buffalo houses, aptly named the "Twin Residences," are almost identical in size, arrangement, and construction. The central fan-blast type heating systems are also similar, and present some exceptional features in design, layout, and construction.

CENTRAL fan-blast heating and ventilating systems rapidly gain favor for the better types of residences. This unusual "Twin-Residence" job in Buffalo is a good illustration of the trend. It also shows that rust-resisting Ingot Iron is the safe and sensible metal for ducts, risers, and other parts that must endure.

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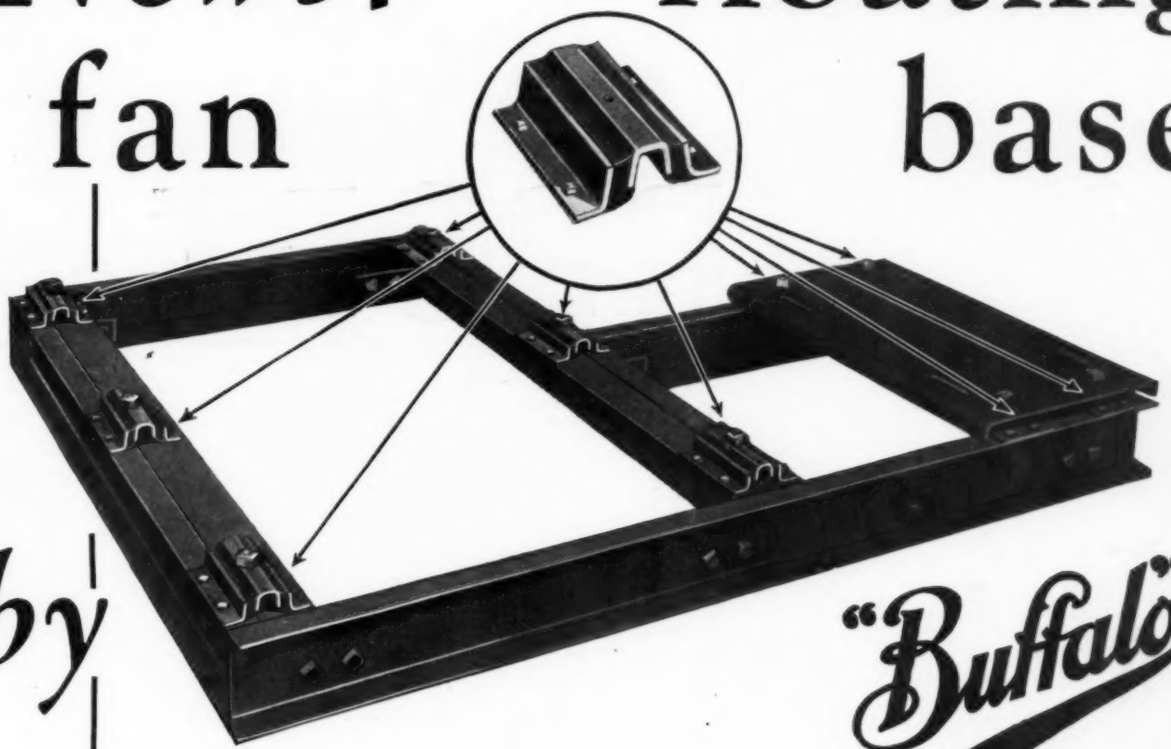

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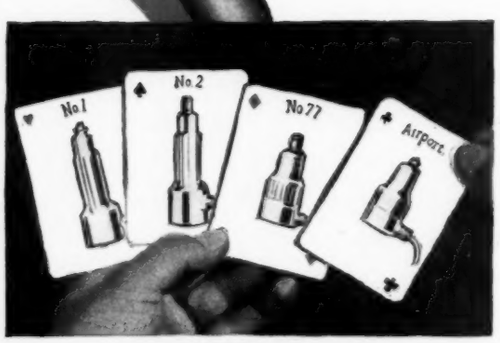

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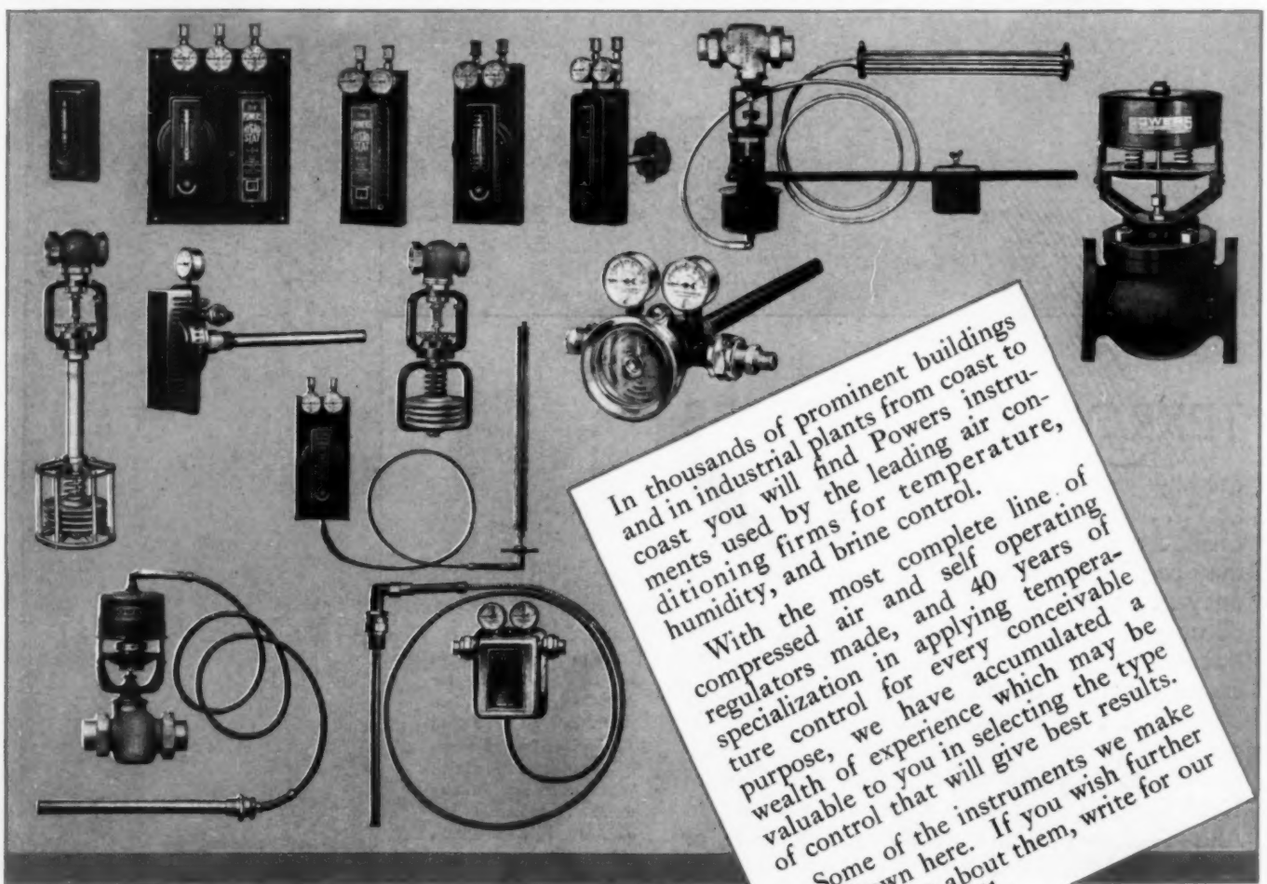

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The EDITOR'S PAGE

Heating · Piping *and* Air Conditioning

Great is the effect of the piping, the pressure-reducing stations, desuperheating equipment, etc., on the satisfactory operation of an industrial process steam plant. Such plants present many unusual design problems and too much attention cannot be given the layout of the piping and the piping "accessories." Amount of byproduct power that can be generated depends on the pressure drop in the lines; frequently, steam at two or more pressures is required for different processes; steam must be desuperheated.

E. C. Gaston's article in this issue analyzes some of these problems and presents data which are of aid in solving them successfully.

That air conditioning is a potent factor in national and world economics is stressed by Willis H. Carrier in his paper recently presented at a meeting of the A. I. E. E. and from which his article in this number is taken. The benefits of conditioned air in raising production and lowering cost in industrial installations is described, and a number of typical cases are reported—industrial engineers considering air conditioning in connection with their own production problems will find these case-histories of no little value.

Air conditioning for human comfort is equally a money-maker, as shown by the experiences of department stores, office buildings, restaurants, theaters, railroads, and in many other applications. Air conditioning may be the key to the development of the wealth of the tropics. Its future growth means much to business and employment all over the world.

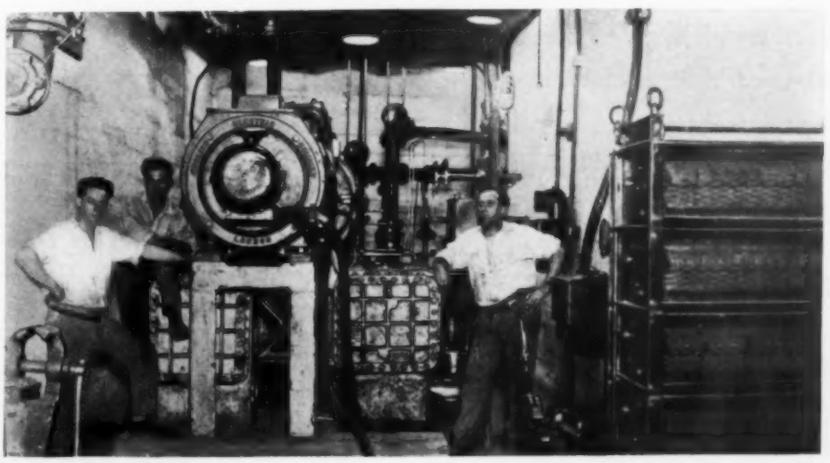
Extensive is the use of flow meters for measuring steam, gas, air, water, oil and other fluids in plants and buildings today. To cut costs their sources must be known. Stress on increased operating efficiency in recent years has increased the applications of such meters. Costly piping changes to enable accurate metering are easily avoided through care in the layout of the piping. Louis Gess shows how in his article this month.

MODERNIZATION NEXT ISSUE'S THEME

How plants, office buildings, schools, hotels, hospitals and other large buildings *can save* on heating, piping, and air conditioning costs . . . How plants and buildings *have saved* . . . Trends in equipment developments . . . See the January HEATING, PIPING AND AIR CONDITIONING!

In looking for possible economies in the heating system of a plant or building, the maintenance guide and check-list starting on page 797 of this issue will be found of great aid. Similar in arrangement to the steam-piping and air-conditioning guides and check-lists published in the October and November numbers, the present maintenance help covers steam, vacuum, vapor, hot-water, and warm-air heating systems, and buildings served by district steam. The check-list was compiled by four engineers having wide experience; the questions bring to attention the important points to check and are aimed to suggest other repair or replacement operations which will lead to economical heating.

Air conditioning brings comfort to miners below the earth's surface, permitting profitable operation



Possible and practical variations in the arrangement of control apparatus for motors driving ventilating fans are many, points out Samuel R. Lewis in his article this month. In the modern building some form of centralized control is usually a necessity, as frequently ventilating and air-conditioning equipment is located in many spaces throughout the building. In his article, Mr. Lewis describes how electricity and compressed air are used for controlling fan motors; diagrams show interesting applications.

Guide to a wealth of information published during 1932 is the volume index in this issue of HEATING, PIPING AND AIR CONDITIONING. Progress in the engineering and equipment development of heating and air conditioning has been outstanding in recent months, despite the depression in business which has affected all fields. Air conditioning, growing in importance every day, has been benefited by numerous technical and engineering articles. The subject of heating has received major attention.

The index of piping articles further stresses the importance of piping services in every plant and building. Proper piping is essential to almost every industrial and commercial installation; much depends on its carefully-engineered design and layout, its installation and its maintenance.

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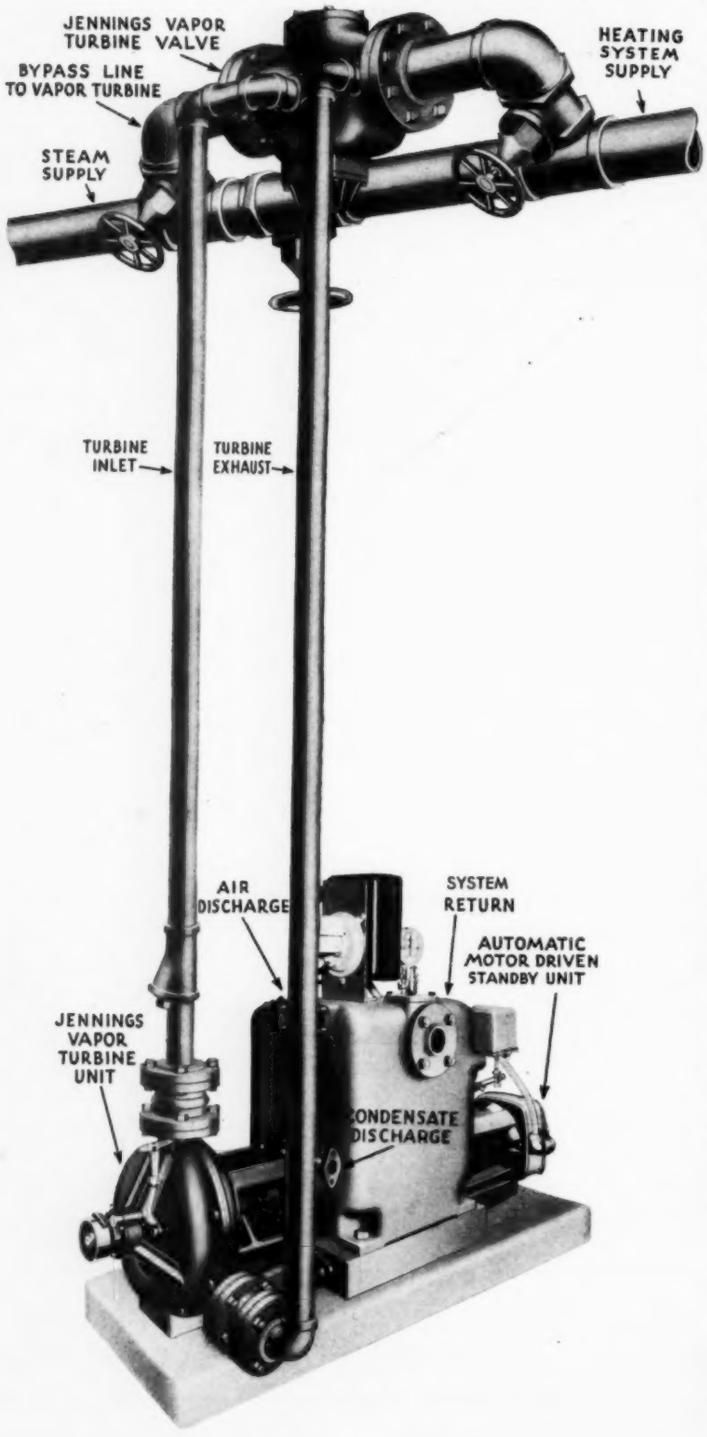
THE NEW JENNINGS HEATING PUMP

THAT OPERATES DIRECTLY FROM THE SYSTEM STEAM.



Here is a return line heating pump meeting the modern demand. The Jennings Vapor Turbine requires no electric current. It operates on steam directly from the heating mains, and returns that steam to the heating system with practically no heat loss. Electric current, the one biggest item in the cost of operating a return line heating pump has been eliminated.

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Sturdy and simple in construction, this pump has all of the advantages that have made Jennings Heating Pumps a "buy" word to American Engineers. They have the exclusive Jennings feature of separation under vacuum, air and water being handled separately in pumping elements designed for each. Balanced bronze rotors rotate on high grade ball bearings without metallic contact with the casing.

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Jennings Pumps

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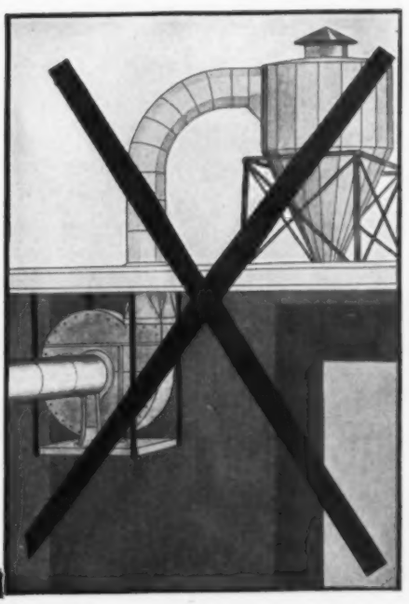
TURBO-CLONE is already in use in a number of industries where dust—whether valuable or objectionable—must be collected. Its performance is exciting enthusiastic praise. If you have a dust problem you should know more about this revolutionary development. Send for literature and complete engineering data.



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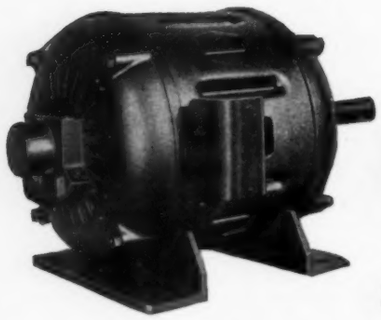
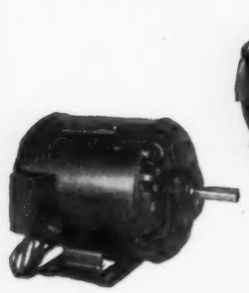
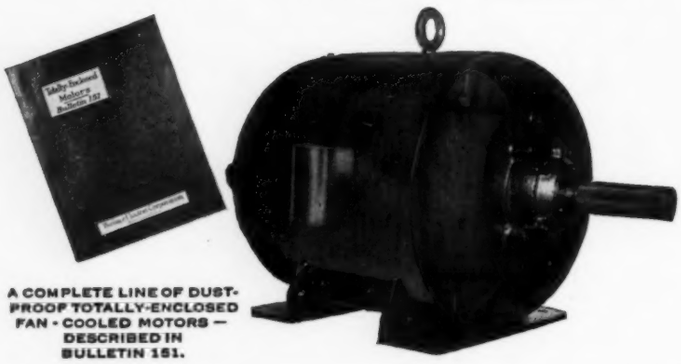


A COMPLETE LINE OF SQUIRREL-CAGE MOTORS — DESCRIBED IN BULLETIN 174.



A COMPLETE LINE OF FRACTIONAL HORSEPOWER MOTORS — DESCRIBED IN BULLETIN 167.



A COMPLETE LINE OF DUST-PROOF TOTALLY-ENCLOSED FAN-COOLED MOTORS — DESCRIBED IN BULLETIN 151.

The following are some of the reasons why Wagner motors are chosen by motor users:

1. A complete line of polyphase and singlephase motors—an assurance to motor buyers that Wagner recommendations are made without prejudice, and that at no time will the wrong type of motor be supplied.
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Please send copy of the following:

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[Place an "X" in squares before bulletins desired.]

Name and Position.....

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STRENGTH

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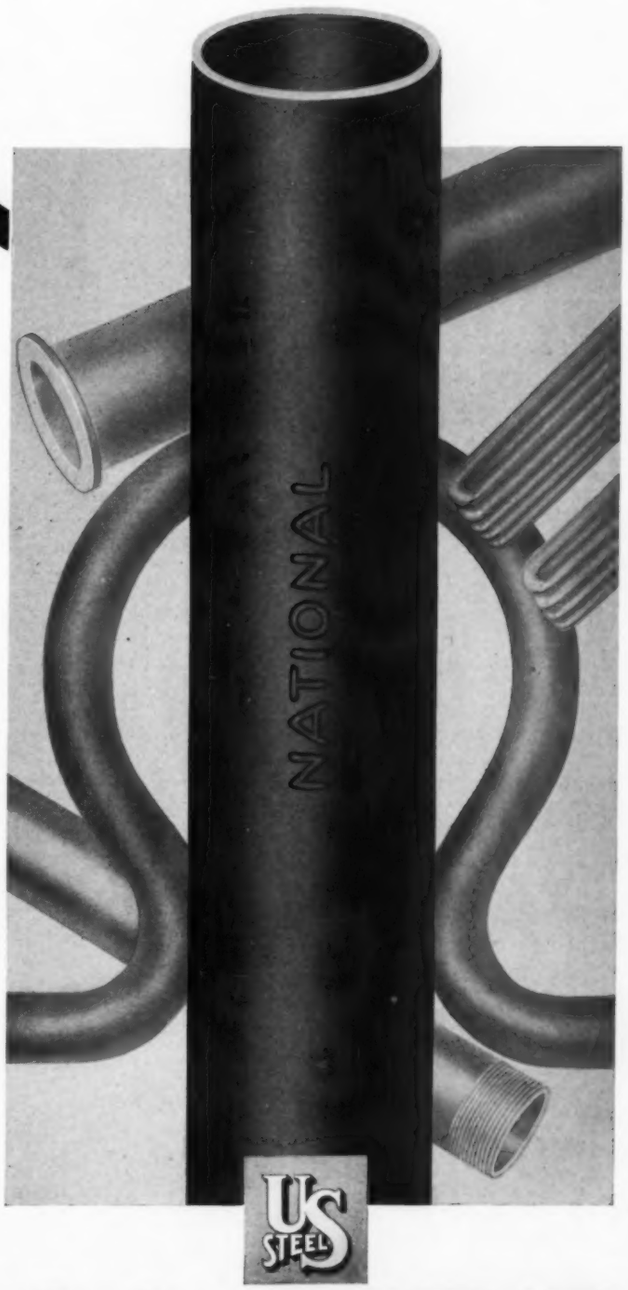
of its advantages



IN any case where pressures, vibration, and varying temperatures must be endured by a piping system, strength is indispensable, of course; but strength is not all that is to be considered. Workability is likewise important, where the pipe must stand bending, flanging and coiling.

Corrosion resistance is of undeniable importance, for it will be the measure of strength or life of the pipe as time passes. Adaptability to any form of joint making is a highly desirable quality. A complete range of sizes and wall-thicknesses to meet a wide range of requirements is also of decided value, while the satisfaction that comes from the assurance that each and every length is uniform, thoroughly tested, has passed a rigid inspection and conforms to recognized standard specifications is an advantage that is too important to be overlooked in any piping job.

Experienced users of pipe everywhere recognize these advantages as inherent in NATIONAL Pipe —advantages that have made it—

America's Standard Wrought Pipe

NATIONAL TUBE COMPANY · Pittsburgh, Pa.
Subsidiary of United States Steel Corporation

NATIONAL PIPE

WELDED OR SEAMLESS

STEEL FOR STRENGTH

THE trend is toward steel—toward Yarway Welded Steel Expansion Joints for permanence, safety, convenience, real savings in installation and maintenance costs. Compare them point by point. (1) Cylinder guided sliding sleeve, made of chromium-covered wrought steel or centrifugally cast bronze, resists corrosion and erosion. (2) Cylinder guide surrounded by hot liquid or steam at all times, expands equally with the sleeve, securing extremely close clearance with freedom of movement. (3) Alemite lubrication of sliding sleeve and cylinder guide. (4) Easily accessible packing gland for adjustment and repacking. Large, deep stuffing box. (5) Sliding sleeve away from inside bottom of body dirt pocket, prevents rust, scale, sand, etc., from cutting sleeve. (6) Smaller diameter than pipe flange—no large tunnel space required. Investigate this improved joint that is rapidly gaining preference. Write for further information.

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Mermaid and Anderson Streets Chestnut Hill, Philadelphia

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Frick Refrigeration
FRICK
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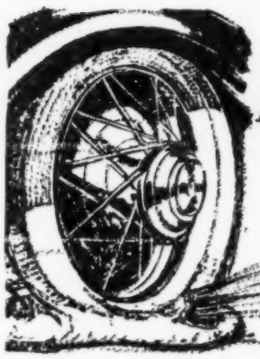

Get the AIR-REMOVAL CAPACITY of a "Blowout" with a new ARMSTRONG TRAP thermic vent

THE exclusive Armstrong development shown at the left below will vent air many times as fast as the ordinary steam trap. Almost any desired air removal capacity can be provided.

The standard Armstrong Trap vents air automatically as shown at the lower right and for most types of service this arrangement is entirely satisfactory. The thermic vent is added when submerged coils, unit heaters, steam heated cylinders or other similar installations require the extremely rapid elimination of a very large volume of air.

If you have a problem in venting air, take it up with the Armstrong representative or write us. The new Armstrong thermic vent offers a standard of service on such jobs never before available.

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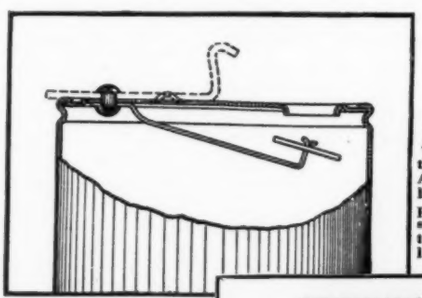
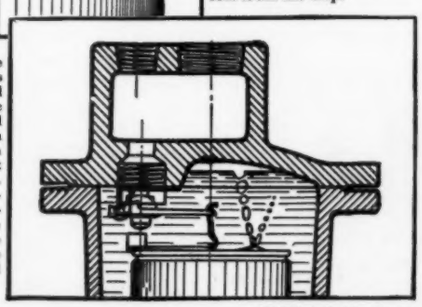


Below: **The air vent in the top of the inverted bucket in an Armstrong Trap prevents air binding. Any steam that passes through the small standard vent is condensed to make up for radiation loss from the trap.**



Above: **The large vent is closed by a flat disc fastened to the end of a strip of thermic metal. When the trap is cold the vent is open as shown allowing air to pass through so rapidly that the bucket cannot float and the discharge orifice therefore cannot be closed. As the temperature in the bucket rises, the bending of the thermic strip closes the vent and the trap functions in the normal manner.**

HP&AC-12-Gray

Chicago's Great New Post Office

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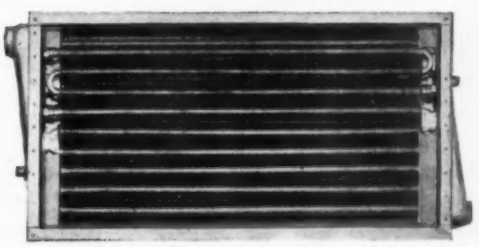
Fan Blast Heat Surface

Installed Throughout



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AEROFIN won out again, as in hundreds of installations, because of superior design and workmanship and for its exclusive features.

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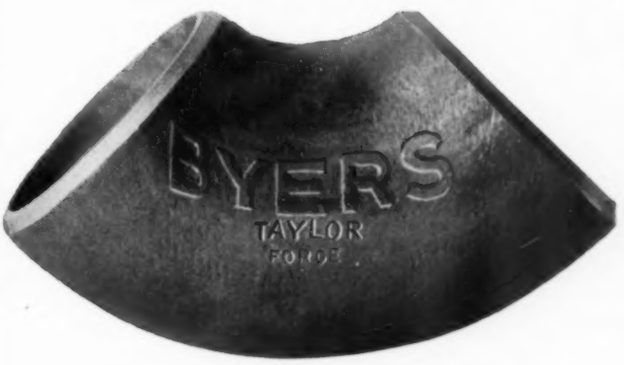

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Sturtevant Co., Inc., B. F., Boston, Mass.
Trane Co., The, La Crosse, Wis.

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Clarage Fan Co., Kalamazoo, Mich.
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Multicell Radiator Corp., Lockport, N. Y.
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(See Systems)

HEATING SYSTEMS, VAPOR
(See Systems)

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(See Systems)

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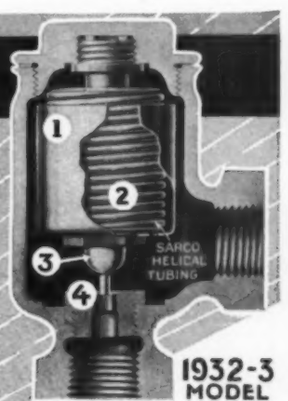

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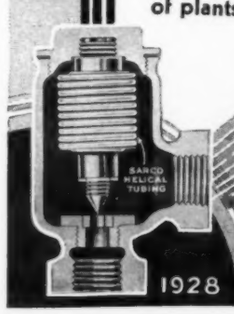

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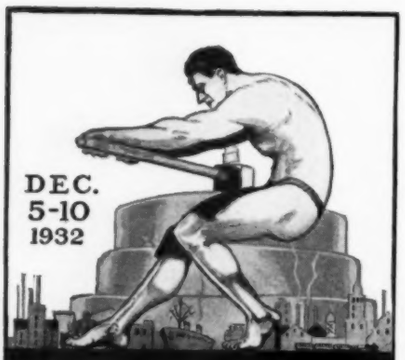
SARCO STEAM TRAP



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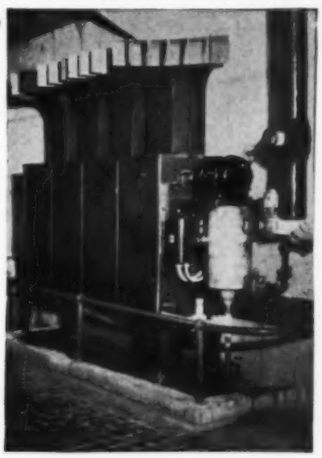

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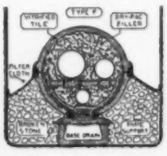

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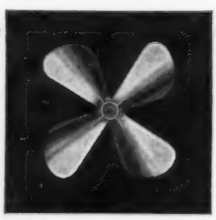

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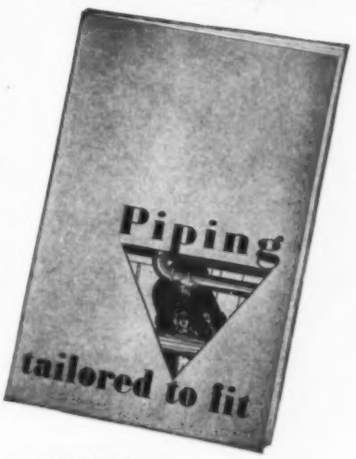

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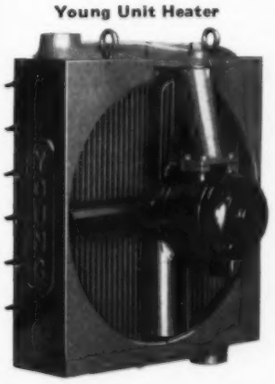

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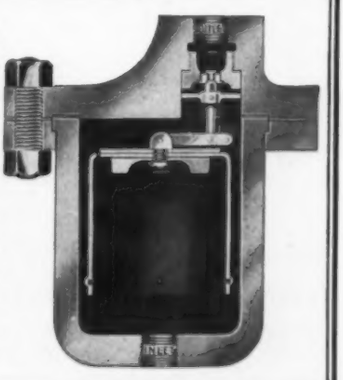

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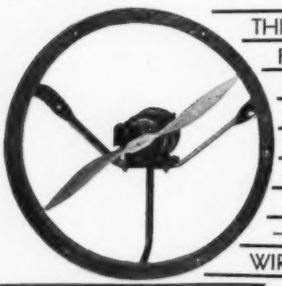

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Grinnell Co., Inc., Providence, R. I.
Kennedy Valve Mfg. Co., Elmira, N. Y.

VALVES, EXHAUST RELIEF
Davis Regulator Co., Chicago

VALVES, EXHAUST AND RELIEF
Crane Co., Chicago, Ill.
Jenkins Bros., New York City
Kennedy Valve Mfg. Co., Elmira, N. Y.
Mason Regulator Co., Boston
Scott Valve Mfg. Co., Detroit

VALVES, FLOAT
Crane Co., Chicago, Ill.
Davis Regulator Co., Chicago
Kennedy Valve Mfg. Co., Elmira, N. Y.

VALVES, FLOAT, AMMONIA
Alco Valve Co., Inc., St. Louis, Mo.
Kennedy Valve Mfg. Co., Elmira, N. Y.

VALVES, FUEL OIL
Alco Valve Co., Inc., St. Louis, Mo.
Crane Co., Chicago, Ill.
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Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.

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Crane Co., Chicago, Ill.
Jenkins Bros., New York City
Kennedy Valve Mfg. Co., Elmira, N. Y.
Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Strong, Carlisle & Hammond Co., Cleveland

VALVES, GATE
American Radiator Co., New York
Crane Co., Chicago, Ill.
Jenkins Bros., New York City
Kennedy Valve Mfg. Co., Elmira, N. Y.
Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.
Scott Valve Mfg. Co., Detroit

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Kennedy Valve Mfg. Co., Elmira, N. Y.

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Scott Valve Mfg. Co., Detroit

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Kennedy Valve Mfg. Co., Elmira, N. Y.

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Barber-Colman Co., Rockford, Ill.
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Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

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Jenkins Bros., New York City
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Strong, Carlisle & Hammond Co., Cleveland
Scott Valve Mfg. Co., Detroit

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Kennedy Valve Mfg. Co., Elmira, N. Y.
Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

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Barber-Colman Co., Rockford, Ill.
Jenkins Bros., New York City
Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.

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Crane Co., Chicago, Ill.
Jenkins Bros., New York City
Kennedy Valve Mfg. Co., Elmira, N. Y.
Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.
Scott Valve Mfg. Co., Detroit

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Crane Co., Chicago, Ill.
Davis Regulator Co., Chicago
Jenkins Bros., New York City
Kennedy Valve Mfg. Co., Elmira, N. Y.
Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.
Scott Valve Mfg. Co., Detroit
Strong, Carlisle & Hammond Co., Cleveland

VALVES, POP
Scott Valve Mfg. Co., Detroit

VALVES, PRESSURE REDUCING AND REGULATING
Air Reduction Sales Co., New York
Crane Co., Chicago, Ill.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Linde Air Products Co., New York
Mason Regulator Co., Boston
Powers Regulator Co., Chicago
Strong, Carlisle & Hammond Co., Cleveland

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American Radiator Co., New York
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Crane Co., Chicago, Ill.
Hoffman Specialty Co., Waterbury, Connecticut
Jenkins Bros., New York City
Kennedy Valve Mfg. Co., Elmira, N. Y.
Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Trane Co., The, La Crosse, Wis.
Warren Webster & Co., Camden, N. J.

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American Radiator Co., New York
Crane Co., Chicago, Ill.
Hoffman Specialty Co., Waterbury, Connecticut
Jenkins Bros., New York City
Kennedy Valve Mfg. Co., Elmira, N. Y.
Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Sarco Co., Inc., New York City

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Crane Co., Chicago, Ill.
Hoffman Specialty Co., Waterbury, Connecticut
Jenkins Bros., New York City
Kennedy Valve Mfg. Co., Elmira, N. Y.
Sarco Co., Inc., New York City
Strong, Carlisle & Hammond Co., Cleveland
Trane Co., The, La Crosse, Wis.
Warren Webster & Co., Camden, N. J.

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American Radiator Co., New York
Crane Co., Chicago, Ill.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Mason Regulator Co., Boston
Scott Valve Mfg. Co., Detroit

VALVES, SAFETY
Crane Co., Chicago
Jenkins Bros., New York City
Kennedy Valve Mfg. Co., Elmira, N. Y.
Scott Valve Mfg. Co., Detroit

VALVES, SOLENOID
Alco Valve Co., Inc., St. Louis, Mo.
General Electric Co., Schenectady
Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

VALVES, STOP AND CHECK
(See Valves, Non-Return)

VALVES, TEMPERATURE CONTROL
Alco Valve Co., Inc., St. Louis, Mo.
Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

VALVES, THREE AND FOURWAY
Crane Co., Chicago, Ill.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Nicholson & Co., W. H., Wilkes-Barre, Pa.

VALVES, THROTTLE
Kennedy Valve Mfg. Co., Elmira, N. Y.
Reading-Pratt & Cady Co., Inc., Bridgeport, Conn.
Strong, Carlisle & Hammond Co., Cleveland

VALVES, VACUUM BREAKING
Kennedy Valve Mfg. Co., Elmira, N. Y.
Scott Valve Mfg. Co., Detroit
Skidmore Corp., St. Joseph, Mich.

VALVES, VENTING, FOR RETURN MAINS
(See Vents, Air Heating)

VENTILATING SYSTEMS
(See Systems, Ventilating)

VENTILATORS, FARM BARN
Ilg Electric Ventilating Co., Chicago.

VENTILATORS, FLOOR
Clarage Fan Co., Kalamazoo, Mich.

VENTILATORS, KITCHEN
Ilg Electric Ventilating Co., Chicago.

VENTILATORS, MUSHROOM
Clarage Fan Co., Kalamazoo, Mich.

VENTILATORS, ROOF
Clarage Fan Co., Kalamazoo, Mich.
Ilg Electric Ventilating Co., Chicago.
Wing Mfg. Co., L. J., New York

VENTILATORS, UNIT
Diehl Mfg. Co., Elizabethport, N. J.
Ilg Electric Ventilating Co., Chicago.
Sturtevant Co., Inc., B. F., Boston, Mass.
Trane Co., The, La Crosse, Wis.
Wing Mfg. Co., L. J., New York

VENTS, AIR, HEATING
American Radiator Co., New York
Hoffman Specialty Co., Waterbury, Connecticut
Sarco Co., Inc., New York
Trane Co., The, La Crosse, Wis.

VENTS, TRAP, STEAM
Barnes & Jones, Jamaica Plain, Boston, Massachusetts
Hoffman Specialty Co., Waterbury, Connecticut
Sarco Co., Inc., New York
Trane Co., The, La Crosse, Wis.
Warren Webster & Co., Camden, N. J.

WALL BOXES, DIRECT-INDIRECT RADIATOR
(See Boxes)

WASHERS, AIR
American Moistening Co., Providence, R. I.
Buffalo Forge Co., Buffalo, N. Y.
Ilg Electric Ventilating Co., Chicago.
Maryland Air Conditioning Corp., Baltimore, Md.
Sturtevant Co., Inc., B. F., Boston, Mass.

WATER HEATERS
(See Heaters)

WATER LEVEL CONTROLS
(See Controls, Water Level)

WATER LEVEL INDICATORS
(See Indicators, Water Level)

WATER SOFTENERS
(See Softeners, Water, Automatic)

WELDING EQUIPMENT
Air Reduction Sales Co., New York
General Electric Co., Schenectady
Linde Air Products Co., New York
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

WELDING FLUXES
Air Reduction Sales Co., New York
Linde Air Products Co., New York

WELDING ROD
Air Reduction Sales Co., New York
American Brass Co., New York
Linde Air Products Co., New York

WHISTLES
Crane Co., Chicago, Ill.

WIRE, WELDING
Air Reduction Sales Co., New York
Linde Air Products Co., New York

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Bonney Forge & Tool Works, Allentown, Pa.
Crane Co., Chicago, Ill.

WRENCHES, SPUD, RADIATOR
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Radiator Sales Opportunity

Long established, well rated manufacturer is now in production on a new type of heating radiator which authorities claim to be the most attractive and highly developed radiator yet produced.

Applications for sales rights in various territories are now being received. Substantial immediate profits and a promising future are available to those selected.

Properly qualified sales representatives who can operate upon a straight commission basis should write for particulars. State experience, connections and sales records. Address P. O. Box 1222, Pittsburgh, Pa.

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IT WILL PAY YOU TO OPEN THIS DOOR

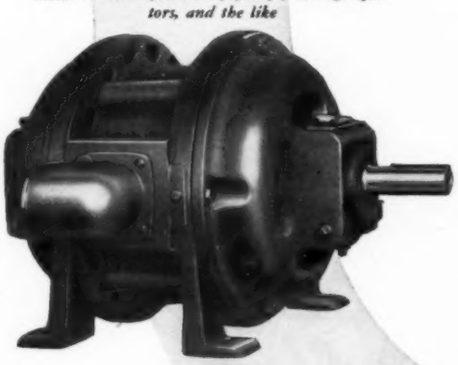
If you have a drive problem for PUMPS

G-E vertical induction motor—the RIGHT motor to drive your sump pumps, sewage ejectors, and the like

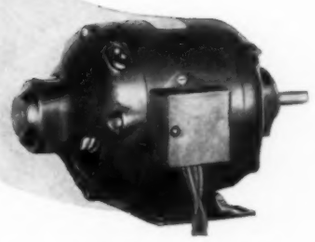
GENERAL ELECTRIC can supply the RIGHT type and the RIGHT size of motor, fractional or integral horsepower, for the job, and the RIGHT control, either manual or automatic, for the motor.

Before you buy any electric equipment, consider these factors of G-E service: engineering help; prompt manufacturing and shipping coöperation; immediate stock shipments from conveniently located warehouses when standard supplies are desired quickly; a nation-wide chain of service shops—one of which is conveniently near you; highly trained specialists to deal with in every transaction. These are the factors that should help you choose the RIGHT equipment.

It will pay you to bring your electrical problems to General Electric. There's a G-E office near you, or address General Electric Company, Schenectady, N. Y.



G-E horizontal, squirrel-cage induction motor—the RIGHT motor for spray pumps, brine pumps, and circulating pumps

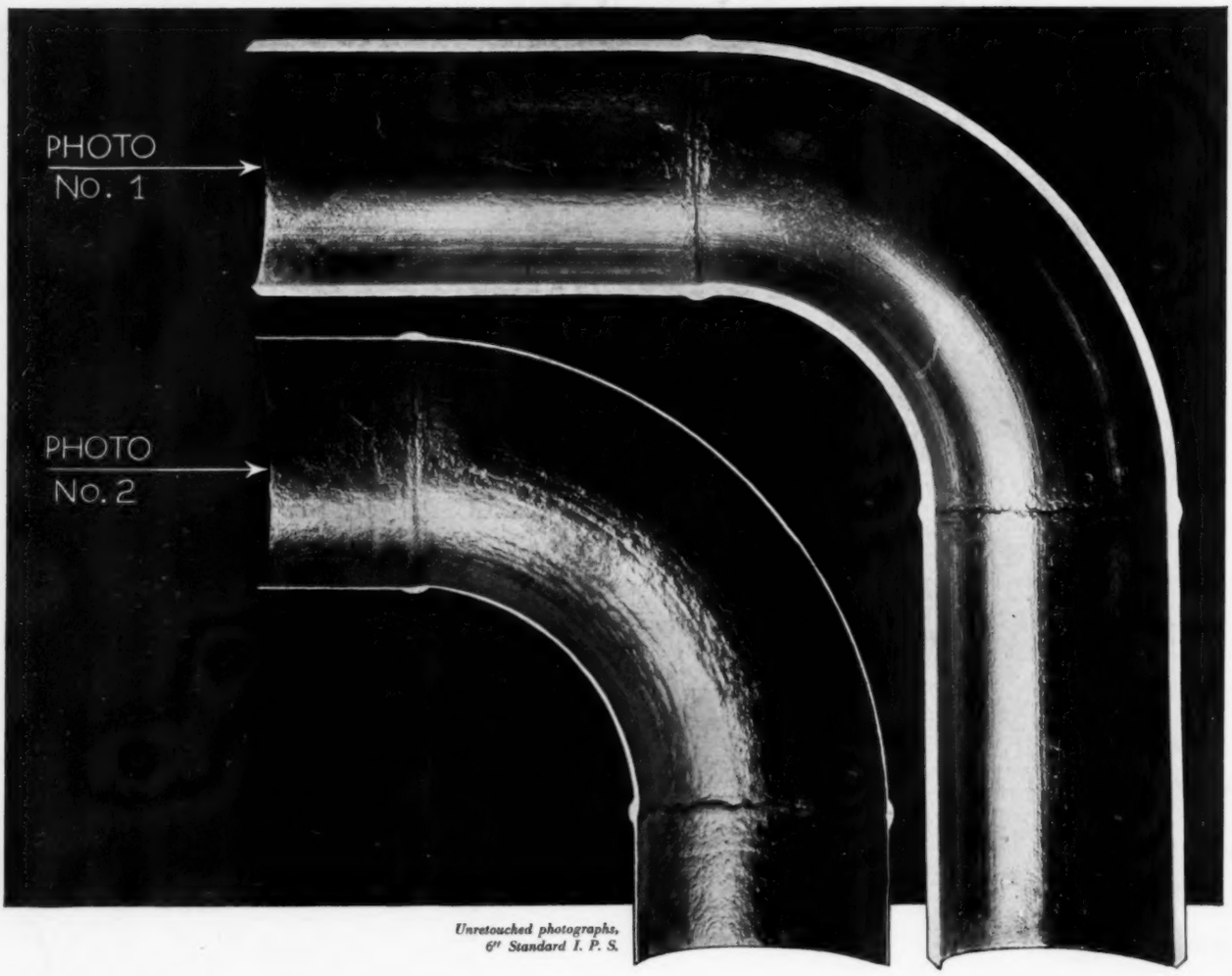


G-E fractional-horsepower motor—typical of the high-quality small motors available for pump drives

These G-E motors are used for pump-drive service, and are representative of the care and experience that make every G-E motor *right* for the job.

200-661

GENERAL ELECTRIC



Unretouched photographs, 6" Standard I. P. S.

IF WALLS COULD TALK!

PHOTOGRAPH No. 2 above is a 6" Tube-Turn 90° welding elbow—a mere shell of its former self, now honorably retired after notable service carrying corrosive, high-velocity refinery vapors.

The *inside* wall of the Tube-Turn lost 61% of its original .280" thickness. The *outside* wall lost 77%!

The *outside* wall lost 20% more than the inside wall!

And the pipe lost more than ANY part of the Tube-Turn!

Contrast Photo No. 2 with Photo No. 1—an exact duplicate of the original No. 2 unit! Look at the welds—still stronger than either the pipe or the elbow.

What would have happened if:

35% of the original wall thickness had been cut away at the start by threading the pipe for a screwed elbow?

Or if:

The elbow had been a hot or cold bend, with its inside wall thickened, and with a consequent thinning of the outside wall!

Easy to see why engineers insist upon *genuine* TUBE-TURNS, with their full thickness on *both* the inside and the outside walls! Easy to see why users of welded piping want the name TUBE-TURN (which applies *only* to the fittings manufactured by TUBE-TURNS, *Incorporated*) on their elbows. It guarantees uniformity of walls—*always*, and at *all* points.

In other words, *there's no uncertainty about Tube-Turns. . . .* Write for all the facts. *Address:* Tube-Turns, *Incorporated*, 1309 Shelby Street, Louisville, Kentucky.

TUBE-TURNS